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Appendix E

The Delphi: Insecticide Use and Lint Yields

Beltwide Boll Weevil/Cotton
Insect Management Programs

The Delphi: Insecticide Use and Lint Yields, Beltwide Boll Weevil/ Cotton Insect Management Programs, Overall Evaluation Appendix E. Natural Resource Economics Division, Economic Research Service; U.S. Department of Agriculture; Washington, D.C. 20250; May 1981.

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ABSTRACT

The Delphi, a method for systematic collection of information from experts, was modified to obtain biological data required for the economic analysis of boll weevil/cotton insect management programs. Cotton insect management and crop production experts provided detailed data regarding the insecticide use patterns and cotton lint yields they projected would result under each of five alternative insect management options, in 35 subregions of cotton production. These data were used to estimate average insecticide use and cotton lint yield of six boll weevil/cotton insect management programs. Producers' average insect control costs under each program also were calculated from the information provided by the Delphi experts.

PREFACE

This report provides estimates of farm level impacts of alternative boll weevil/cotton insect management programs in weevil infested areas of the U.S. These estimates are critical elements of the economic and environmental evaluations of alternative programs.

Estimated impacts on cotton producers' insecticide use and cotton lint yields were determined through a modified Delphi (expert opinion) process. Over 70 people contributed to the planning, implementation, summarization, and evaluation of the Delphi results. Of principal importance were the 35 cotton expert Delphi panel members. It is primarily through their contribution of effort that the successful aspects of the Delphi project were realized. Also, 18 cotton insect management specialists and cotton producers provided expertise and experience as resource people to the Delphi panelists. The Economics and Statistics Service assumed responsibility for organizing and managing the Delphi, while other USDA and State agencies, industry representatives, and cotton producers provided the necessary expertise for estimating farm level impacts.

The Delphi project received overall administration from Velmar Davis, ESS. This report was primarily prepared by Katherine Reichelderfer, ESS. Contributions to its preparation also were provided by Gerald Carlson (North Carolina State University), Herman Delvo (ESS), Dave Parvin (Mississippi State University), John Schaub (ESS), and Irving Starbird (ESS).

Key members of the Delphi Team were:

Katherine Reichelderfer - - Delphi Leader
Velmar Davis - - Overall Evaluation Leader
William Cross - - Biological Evaluation Team Leader
Irving Starbird - - Economic Evaluation Team Leader
Gerald Carlson - - Facilitator
Herman Delvo - - Facilitator
Dave Parvin - - Facilitator
John Schaub - - Facilitator
Richard Ridgway - - Coordinator of Resource Materials
Ed Lloyd - - Biological Evaluation Team
Fred Cooke - - Economic Evaluation Team

CONTENTS

TABLES

ATTACHMENTS

ACRONYMS

APHIS	Animal and Plant Health Inspection Service, USDA
ASCS	Agricultural Stabilization and Conservation Service
B/C	Benefit/Cost Ratio
BWE	Boll Weevil Eradication or Trial
CES	Cooperative Extension Service
CIC	Current Insect Control
CIC-BWE	Current Insect Control with Boll Weevil Eradication
ESS	Economics and Statistics Service, USDA
MOPM	Modified Optimum Pest Management Option
NCDA	North Carolina Department of Agriculture
OBP&E	Office of Budget, Planning and Evaluation, USDA
OPM	Optimum Pest Management Option or Trial
OPM-NI-BWE	Optimum Pest Management with No Incentive and Boll Weevil Eradication
OPM-I	Optimum Pest Management with Continuing Full Incentive Payments to Producers for Diapause and/or Pinhead Square Treatments
OPM-NI	Optimum Pest Management with No Incentive Payments to Producers
OPM-PI	Optimum Pest Management with Phased Incentive Payment to Producers
OPMREEAC	Optimum Pest Management Regional Extension Education Advisory Committee
SEA-AR	Science and Education Administration-Agricultural Research, USDA
VADAC	Virginia Department of Agriculture and Commerce

THE DELPHI: INSECTICIDE USE AND LINT YIELDS
Beltwide Boll Weevil/Cotton Insect Management Programs

SUMMARY

Pesticide use and costs, and cotton lint yields were estimated for six boll weevil/cotton insect management programs: current insect management practices (CIC); adoption of optimum pest management programs (increased Extension education) with three alternative incentive options for boll weevil diapause control (full, partial, none) identified as OPM-I, OPM-PI, and OPM-NI; and two boll weevil eradication programs, one with optimum pest management (OPM-NI-BWE), and the other with current practices (CIC-BWE). A modified Delphi was used to estimate insecticide use and lint yields of each program.

Total changes in insecticide use and lint yields from CIC for the five new programs for the boll weevil infested portion of the Cotton Belt are shown below:

Insect control program	Acre treatments w/insecticides	Total producers' insect control costs	Total cotton lint production
	Million acres	Million dollars	Million pounds
CIC (Baseline)	35	191	2,890
Changes from CIC			
OPM-I	-1	-44	117
OPM-PI	-4	-21	101
OPM-NI	-4	-21	101
CIC-BWE	-10	-47	116
OPM-NI-BWE	-11	-54	155

Insecticide use and costs, and lint yields vary across cotton production regions. Projected yield increases, from CIC, are generally of greater magnitude in the more Western subregions than in the Mid-south and Southeast. Changes in insecticide use and the producers' cost of insect control, between CIC and OPM-NI-BWE, range from an estimated 33 percent increase in Missouri to a 90 percent decrease in Oklahoma.

These estimates represent farm-level impacts after full program implementation. Neither public cost nor off-farm impacts of the programs were addressed by the Delphi experts.

INTRODUCTION

The economic evaluation of beltwide boll weevil/cotton insect management programs requires many kinds of data. Estimates of insecticide use and lint yields are especially important because they reflect the benefits of the programs.

Beltwide estimation of insecticide use and lint yields was infeasible experimentally and was unsuccessful by traditional analytical techniques.
Actual and simulated insecticide use and yield data were available only for the boll weevil trial areas. Eradication was pilot tested in North Carolina and an optimum pest management trial was conducted in Mississippi. Because of wide differences in insect infestations, climatic conditions, soils and a variety of other factors, the results of the trials could not be extrapolated across the cotton belt. The complexity of cotton insect problems and production, coupled with a relative lack of data, frustrated attempts to estimate beltwide yield or insecticide use changes by multiple regression and simulation techniques.

A systematic method for collecting consistent data bases was required. A modified Delphi approach was chosen for this purpose.

The major objective of the Delphi was to determine from a varied group of cotton experts its best expectations regarding insecticide use and cotton yield changes given different areawide changes in cotton insect management. These experts would draw on their broad and varied experiences with cotton production, pest control, farmer behavior, geographical considerations and other relevant factors. Their judgements would be aided by general resource staff and the entire process would be structured by a facilitator to obtain scientifically defensible information for program decisionmaking. In particular, the data to be obtained were:

1. subregional average per acre insecticide use under each of five management options: current insect control (CIC); two optimum pest management options (OPM and MOPM); and two boll weevil eradication options (CIC-BWE and MOPM-BWE), and

2. subregional average per acre cotton lint yield under each of the five management options.

The insecticide use data collected from the Delphi panels were used to calculate the subregional average per acre direct cotton insect control costs under each of the five management options.

The data sets developed through the Delphi process were critical components of the overall evaluation of beltwide boll weevil/cotton insect management programs. These data were required input to AGSIM, the econometric-simulation model (described in the Economic Evaluation Report) that was used to determine changes in the market equilibrium quantity and price of cotton, given changes in average cotton costs of production and yield.

In the sections that follow the concept of the traditional Delphi method is discussed along with a listing of advantages and disadvantages. The organization of the modified cotton Delphi, its questionnaire, and the process of estimating data are described. Data tabulation methods are then outlined. Lastly, insecticide use and cost and lint yield estimates are summarized for

beltwide boll weevil/cotton insect management options, and programs and the Delphi results are evaluated.

THE DELPHI APPROACH

The Delphi is a systematic approach for the collection of information from experts. It utilizes a high degree of intuitive judgment based on experience and other insights. Intuition and judgment are indispensable ingredients of research and analysis in the social sciences and frequently supplement quantitative models in the natural and biological sciences as well.

The Delphi method was developed by the Rand Corporation in the 1950's and first used to estimate the probable effects of an atomic bomb attack on the United States. Since then, it has had widespread use in technological forecasting, and its uses have proliferated (7). As Linstone and Turoff point out, it still lacks a sound theoretical basis since it relies on expert opinion. Further, it places "considerable demands on the integrity of the method and of its practitioners."

While no single definition of the Delphi is appropriate for all applications, the following characterize the approach. Delphi is: "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem" (7); "a technique used for the elicitation of opinions with the object of obtaining a group response of a panel of experts" (2); and "characterized by three features which distinguish it from the usual methods of group interaction. These are: (a) anonymity; (b) iteration with controlled feedback; and (c) statistical group response...The Delphi is not really a single method, but a family of methods, basically all modifications of, or variations on, the approach developed at Rand" (8).

The Delphi is adaptable to a wide range of inquiries, but the specific form or structure of the communication process should match the objective and not be rigidly applied over all possible applications. As a minimum, however, the Delphi was designed to provide for four underlying processes:

(1) Some feedback of individual contributions or responses

(2) Some assessment of the group judgment or view

(3) Some opportunity for individuals to revise their responses

(4) Some degree of anonymity for the individual responses

The method in its usual applications involves the use of a questionnaire mailed to each selected "expert." A small monitor team summarizes the results and develops a new questionnaire to be returned to the initial respondents, who are given at least one chance to revise their initial estimates on the basis of how the group views the problem or issue. Respondents in the second "round" are asked to give reasons for their estimates or opinions and these reasons are summarized and presented to other participants in the next round. This procedure attempts to improve the estimates, or strive for a concensus, without face to face confrontations. In each succeeding round, the feedback data would include an average or median response as well as the interquartile range or other appropriate measures of distribution. The number of iterations

depends on the extent of disagreement and the need to explore the reasons for the differences. Experience indicates that no more than three rounds are usually needed, and that any additional reduction in variance comes at a high cost. Some Delphies ask respondants to rank the degree of confidence in their responses. Some procedures ask for "best", or "most likely" estimates as well as low and high estimates that would bracket the range of expectations.

Advantages

The literature lists several general reasons or justifications for using the Delphi:

(1) The Delphi provides a systematic method to examine problems that cannot be solved by precise analytical techniques.

(2) Many individuals, or those with varied backgrounds, are needed to explore complex relationships.

(3) The approach capitalizes on the availability of informed, expert subjective judgement on a collective basis.

(4) The approach reduces or can eliminate undue bias inherent to subjective judgement made on an individual basis.

(5) The process avoids (a) domination of personalities or public opinion (the "bandwagon effect"), (b) hesitation in contradicting superiors or more experienced persons, or (c) fear of what others might think of a position, and

(6) The efficiency of face-to-face meetings can be supplemented by a group communication process.

Disadvantages

Both critics and proponents of the Delphi method warn that it is not a simple concept that is easily employed. Potential problems include:

(1) Imposition of the views and preconceptions of the monitor group by over-specifying the structure of the Delphi or misinterpreting the results (7).

(2) Generating snap answers to ambiguous questions by creating an imprecise survey instrument (10).

(3) Choosing a "good" group of experts. The process is highly vulnerable to the monitor group's concept and mix of experts (10).

(4) Structuring the process so rigidly that adaptations to unanticipated events cannot be made.

(5) Ignoring and not exploring disagreements, leading to an artificial concensus, or forcing a specious concensus based on group suggestions (7, 10).

(6) Inadequately summarizing and presenting the group response and ensuring common interpretation (7, 10), and

(7) Underestimating the demanding nature of the Delphi (7).

The following sections describe the modified Delphi that was used in the boll weevil/cotton insect management evaluation. The procedure was designed to take advantage of the positive aspects of the approach while minimizing the potential problems listed above.

ORGANIZATION OF THE MODIFIED COTTON DELPHI 1/

The Cotton Expert Panel

A well rounded, diverse group of cotton management experts was needed to fulfill the basic requirements for a workable Delphi approach. The organization of the expert panels was based on major cotton production regions. This regional breakdown assured a relatively common knowledge and experience base and facilitated communication among panel members. Figure 1 deliniates the boundaries of the five Delphi regions (Delphi regions A through E) for which panels were organized.

Panel members were drawn from a range of backgrounds, each of which incorporates different experiences and perspectives concerning cotton insect management. Invitations to participate in the cotton expert Delphi exercise were extended to:

- cotton extension entomologists and/or agronomists,
- cotton research entomologists,
- cotton producers
- private cotton pest management consultants
- chemical industry representatives
- State Department of Agriculture representatives.

An effort was made to cover the entire region by including on each regional panel, individuals whose knowledge would, cumulatively, extend across subregions within the Delphi region. A total of 35 individuals served on the expert panels. Of these, 15 were cotton extension pest management specialists.

Facilitators

Each of the five regional Delphi panels was assigned to a group facilitator. The facilitators' responsibilities were to (1) direct and guide the process of data collection from the regional Delphi panels, (2) prevent domination or undue biasing by any individual or subgroup of the panel, (3) transmit group

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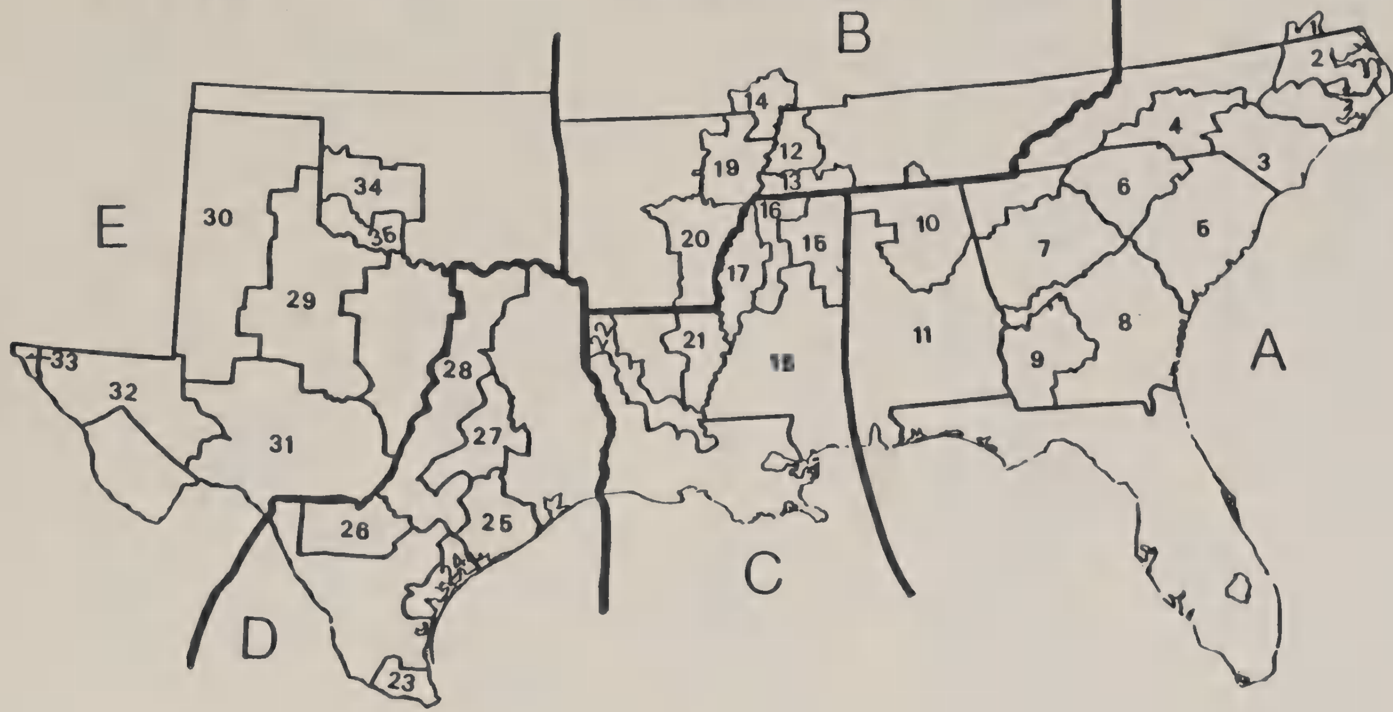
1/ Attachment A illustrates the organization of the Delphi process and identifies the participants for each of the groups described below.

Figure 1. COTTON PRODUCTION REGIONS



summary data to individual panel members, and (4) receive individuals' feedback to the group's average conclusions.

Resource Group

A group of individuals which possessed unique expertise in various aspects of cotton insect management was organized as a set of human resources to be available to the Delphi cotton experts. The Resource Group's responsibilities were to (1) provide background material to the Delphi panel members that would aid them in developing realistic cotton insect management data, (2) clarify or supplement information on specific technical aspects of cotton insect management as needs were identified by any Delphi panel or panel member, and (3) respond, react and provide feedback to panel members and facilitators on interim Delphi results.

Administrative Group

The Delphi was given overall direction by the Leader of the Overall Evaluation Team and was supported by one representative from each of the three boll weevil evaluation teams. Staff assistance for calculation and summarization was provided by research and technical personnel.

THE DELPHI QUESTIONNAIRE

A questionnaire was used to collect experts' opinions on cotton insect management. The Delphi questionnaire (Attachment B) was developed by a group comprised of representatives from the Economic and Biological Evaluation teams and the Delphi Resource Group.

Design

The questionnaire was specifically designed so that experts were asked to estimate the underlying factors that determine cotton yield and insect control costs under various management options. There are three reasons for this design. First, direct estimates of yield and especially cost changes are more difficult to provide than are the changes in management variables that result in those changes. Also, each expert could have a different perception of the term "average change". Some may think in terms of a statistical "mean" average, whereas others could interpret the term as being the most common change observed--statistical mode. By asking for the probability distributions that determine an average value and its variability, internal consistency of the bases upon which estimates were made was preserved. Each expert was guided to use the same thought process. Only under this condition is it valid to combine and compare individual estimates. Lastly, asking for the component relationships that lead to changes in yield and insecticide use provides information needed to substantiate or show the reasons for the observed estimated changes.

Attachment B is a copy of the questionnaire that was developed and used in the Delphi process. The assumptions used in deriving responses, and a brief description of each question follows.

Assumptions

Experts were asked to provide information on current cotton insect control practices (CIC) as well as on expected control patterns under optimum pest management and boll weevil eradication program implementation. The panel of experts was asked to use the following assumptions in providing that information.

1. CIC represents practices over the past five years, with currently known and used technology.

2. Beneficial insects are at average population levels under CIC.

3. CIC descriptions show what cotton producers are doing, not what experts think they should be doing or will be doing in the future.

4. Infestation level is defined in terms of the duration of the cotton season an insect complex is present, the percent of acreage infested, the level of the pest population, and the susceptibility of the cotton fruit.

5. MOPM, OPM, CIC-BWE, and MOPM-BWE are the program options as defined by the Overall Evaluation Team, and shown in Attachment C.

6. OPM is fully implemented and is successful.

7. BWE is fully implemented and is successful.

8. Cotton acreage will not change given MOPM, OPM, CIC-BWE or MOPM-BWE. (The economic evaluation addresses the extent and nature of acreage shifts.)

Information Requested

A separate questionnaire was completed by each Delphi cotton expert for each subregion within the panel's region. For each subregion, information was collected with respect to each program option--CIC, MOPM, CPM, CIC-BWE and MOPM-BWE. The information was collected on a subregional basis for each of the five management options as shown in Attachment B and includes:

1. A listing of target insect complexes and the associated acreage on which each is typically a problem.

2. The insecticide materials used against each target insect complex and the proportion of infested acreage treated and average application rate of each material used.

3. The number of times per year that each specified insecticide material is applied to acreage experiencing zero, light, moderate and heavy infestations of the target insect complex against which it is used.

4. The probabilities of zero, light, moderate and heavy infestation by the target insect complex.

5. Average cotton lint yields, given treatment under each management option, by target insect complex infestation level. (In later rounds of the Delphi, as respondents became more familiar with the process, they were permitted to revise yields directly, though revisions in probabilities still had to be consistent with yield revisions.)

Note that this information provides the data required to estimate insecticide use, insect control costs, and average cotton yields without asking for direct estimates of those essential variables.

THE DELPHI PROCESS

The Delphi process used for boll weevil/cotton insect management evaluation consisted of three major "rounds" of information gathering, feedback, and revision. The three rounds and follow-up actions are described below.

First round

A meeting of the Delphi panels was held in April 1980 to accomplish the first round of the process. It began with an orientation of all panel members on procedural details and background information. Members of the resource group made presentations to familiarize the cotton experts with (1) historical cotton insecticide use, pest control cost, and yield data, (2) results of the OPM and BWE trials, (3) definitions and specifications of beltwide programs, and (4) research on the value of beneficial insects. After the orientation, the panels met in regional groupings to develop estimates for production subregions, using the questionnaire. At the first meeting, descriptions of CIC, OPM and MOPM-BWE, only, were requested.

Questionnaire response by regional Delphi panel members was accomplished in several steps. The facilitator directed the order and process by which individuals responded within a group situation. Conducting the process in a face-to-face situation violated one of the general criteria for a strict Delphi approach. However, anonymity of individual responses was preserved. As a first step, individuals responded anonymously, and without discussion, to the questionnaire asking for information on CIC, by subregion. As individuals' responses were completed for a given subregion, the facilitator made a simple listing of responses, without attaching respondents' names to entries on the list, and displayed it to the group. This step was meant to stimulate discussion and interchange of ideas, and focused on those responses that laid at the outer ranges of the majority of responses. An opportunity for individuals to revise their initial estimates followed the group discussion. The same process of anonymous response, display, and revision was conducted for OPM and MOPM-BWE, by subregion. When possible, given time constraints, summaries of group mean responses, and the range of responses for a given subregion and management option also were displayed, and a second opportunity for revision was made.

Individuals' estimates as filled in on questionnaires during the two day meeting in April constitute first-round Delphi responses.

Second Round

Between April and June, first-round Delphi responses were computerized, and group average insect control costs and total numbers of insecticide applications, by subregion and management option, were calculated. The process by which these calculations were made is described later in this report.

In June, each Delphi panel member was sent the following information:

1. A computerized printout of the individual's responses to each subregional questionnaire he filled out in April. Each member received only his responses. This step verified the computer input.

2. A listing of the regional panel members' summary figures of average insect control cost and number of applications per acre, by subregion and management option.

3. A listing of the regional panel's group averages for insect control cost and number of applications by subregion and management option, and the standard deviation and range associated with each of these group mean estimates.

4. For comparison, estimates of cost and application numbers that had previously been collected from State Extension personnel.

Each Delphi panel member was asked to review his responses for accuracy, to compare his summary figures with those for the group as a whole, and to make revisions based on this review and comparison. The second round revisions were accomplished by mail so that each new revision could be assumed to be independent of any group influence other than the group summary statistics.

First-round estimates were changed to reflect revisions requested by individual respondents and, in that form, represent second-round estimates.

Third Round

The third round of the Delphi process was conducted at another group meeting held in October 1980. As in the first round, the Delphi cotton expert panel members met face-to-face. Objectives were to provide estimates for the MOPM and CIC-BWE options and further refine the previously made estimates for CIC, OPM and MOPM-BWE.

Resource presentations were made to review and provide updated information on survey results and simulation modelling that could be of use to the panel members in providing third round estimates. Final simulation results were not available for presentation to panel members. The bulk of the two day meeting was spent in regional panel group working sessions. The first order of business was to finalize CIC estimates. This activity was followed by work towards differentiation between the two optimum pest management options, finalization of the OPM estimates, and first-time provision of MOPM estimates using the survey questionnaire. Finally, MOPM-BWE estimates were refined and revised, and CIC-BWE estimates were made for the first time. Facilitators followed a detailed set of guidelines (Attachment D) to assure that final results would be consistent across regions.

In addition to review, comparison, feedback and revision of the type requested in round two, several additional check mechanisms were employed. First, panel members were asked to compare their CIC estimates with published data as a way of assessing their accuracy. Secondly, panels' second round group average OPM descriptions were carefully examined to make sure that they met the perfomance criterion for effective OPM (see page 3 of Attachment D, or Attachment C). Third, panel members were asked to compare the diapause/pin head square control program participation rates resulting from their OPM estimates with the Biological Evaluation Team's estimates of what would be required to obtain effective area wide control (Attachment E) to see if significant differences were in evidence.

The third round also had computer terminal facilities available for use in tabulating and summarizing Delphi data revisions made during the third round. Three of the regional panels were able to review their new group averages, comment on and further refine the results of some of their third round revisions during the group meeting. In the other two regional panels, the number of revisions was too great for data processing to be completed within the two day period.

At the end of the two day meeting, data requested for each of the various options had been reviewed, revised, or estimated. A total of 920 sets of questionnaire responses had been reviewed and/or collected. Tabulations of these data sets represent third round estimates.

<u>Follow-up Rounds</u>

During the first half of November 1980, third round results were computed, summarized and sent back to Delphi panel members for another review. There were two primary reasons for this follow-up. First, panel members had not, to this point, had much opportunity to scrutinize and revise their MOPM and CIC-BWE estimates. The follow-up provided this opportunity. Secondly, third round results indicated some regional differences in the manner by which insect control costs and cotton yields varied by management option. The panel members needed to resolve those differences or explain the biological and/or social bases upon which estimated changes were projected.

This follow-up was conducted by telephone. Facilitators obtained from each panel member, reactions to a review of third-round estimates, any changes in individual responses resulting from that review, and statements of rationale for the intraregional relationships observed. Summaries of panel members' rationales are found in Attachment F.

On November 25, 1980, the Delphi facilitators, lead resource biologists and key Economic and Biological Evaluation Team Members met to review the revised third round estimates. Special attention was paid to observed interregional relationships among Delphi estimates. Several subregions were identified as potential problem areas because rationales collected from panel members did not address apparent inconsistencies among management option data. Yield change differences among regions also were discussed. It was determined that the Delphi panelists should have one more opportunity to address these issues and consider last minute revisions before estimates would be finalized.

During the first half of December 1980, Delphi panel members were sent tabular data showing both intra- and interregional Delphi estimates of insecticide use, insect control costs and cotton yields by management option. They were asked to extend their final review of the data to all regions considered, and to examine the estimates made for their own region in light of those made by the other regional panels. Facilitators followed up by phoning each panel member to collect the last minute changes, if any, that each individual wanted to make as a result of his interregional data review. Changes could be made by an individual only with respect to one of his own questionnaire responses, but feedback was welcomed on all estimates provided for review. Results of this last follow up constitute the final Delphi estimates.

DATA TABULATION

Cotton expert Delphi group and individual summary statistics were calculated from Delphi questionnaire responses after each round. A review of the arithmetic processes used to derive estimates of insect control cost, insecticide use and yield by subregion and management option, from the questionnaire responses follows:

Average Number of Insecticide Applications

Questionnaire response data were used to calculate an individual's estimated number of per acre insecticide applications, by subregion and management option, with the following equation:

$$TOTAPPL_{ij} = \sum_{T_{ij}=1}^{n} \sum_{I_{ijT}=1}^{n} (T_{ij})\ (A_{ijT})\ (U_{ijTI}) \sum_{p=zero}^{heavy} (P_{ijT})\ (N_{ijTI}) \ .$$

Where: $TOTAPPL_{ij}$ = an individual's estimated number of insecticide applications for subregion i and management option j.

T_{ij} = target insect complex in subregion i under management option j.

A_{ijT} = proportion of total acreage treated for target complex T in subregion i under management option j.

I_{ijT} = insecticide material used against target complex T in subregion i under management option j.

U_{ijTI} = percent use of insecticide I against target complex T in subregion i under management option j.

P_{ijT} = probability of a (zero, low, moderate or heavy) infestation of target complex T in subregion i under management option j.

N_{ijTI} = number of applications of insecticide material I given (zero, low, moderate or heavy) infestation of target complex T in subregion i under management option j.

The group average estimates of subregional insecticide applications were derived in the following way:

$$NEWSUM_{ij} = \sum_{k=1}^{K} \frac{TOTAPPL_{ijk}}{K}$$

where: $NEWSUM_{ij}$ = group average estimate of the number of insecticide applications made in subregion 1 under management option j.

$TOTAPPL_{ijk}$ = individual k's estimate from above equation

K = number of individuals responding to the questionnaire regarding subregion i, management option j.

The group summary statistic is a simple, unweighted average.

Insect Control Cost

Cotton expert Delphi response data also were used to calculate individual and group summary statistics on average per acre insect control cost. Insecticide material and application cost data were collected independently of the Delphi process to be used in conjunction with questionnaire data in deriving these statistics. Price lists used in this operation are shown in Attachment G. The following formula was used.

$$COST_{ij} = \sum_{T_{ij}=1}^{n} \sum_{I_{ijT}=1}^{n} (T_{ij})(A_{ij})(I_{ijT})(C_{ijTI})(U_{ijTI}) \sum_{p=zero}^{heavy} (P_{ijT})(N_{ijTI})$$

where: $COST_{ij}$ = an individual's estimate of insect control cost per acre in subregion i under management option j.

C_{ijTI} = the cost of a single application of insecticide I, made at the rate indicated for target complex T, in subregion i under management option j.

The group average insect control cost was derived by taking the simple, unweighted average of individual's estimates, similar to NEWSUM above.

Cotton Yield

The panels estimated CIC yield in conjunction with insecticide use for CIC and based on the historical subregional yields (1974-78 average) under CIC that were provided to the panel members. Each Delphi panel member made an estimate of what he felt average subregional cotton yield would be under each of MOPM, OPM, CIC-BWE, and MOPM-BWE. Group average yield estimates were made by summing individuals' estimates for a given subregion and management option, and dividing by the number of respondents. Again, a simple, unweighted average was used.

DELPHI RESULTS

The data presented herein are final estimates resulting from systematic collection of expert opinion from Delphi panel members. The figures shown constitute the data set used to derive farm level input on a regional basis to AGSIM.

Delphi results were generated for five bollweevil/cotton insect management options: CIC; MOPM; OPM; MOPM-BWE; and CIC-BWE. Final Delphi results then were converted to correspond to the six bollweevil/cotton insect management programs being evaluated (CIC; OPM-NI; OPM-PI; OPM-I; OPM-NI-BWE; and CIC-BWE). Subsequent sections of this report present results primarily in terms of management options (as opposed to programs). The similarities and differences among options and programs are described below.

Delphi Options:

- Current Insect Control (CIC) -- assumes insect control as now practiced by producers and implies a continuation of extension education and technical assistance at the present level of funding.

- Modified Optimum Pest Management (MOPM) -- assumes additional extension personnel and support to implement improved insect pest management. The option would utilize all applicable and currently available pest management practices except organized areawide diapause.

- Optimum Pest Management (OPM) -- assumes additional extension personnel and support (same levels as for MOPM) and additionally assumes that areawide diapause and/or pinhead square control is practiced over sufficient acreage to prevent the need for in-season treatment for bollweevils on at least 90 percent of all cotton acreage.

- Modified Optimum Pest Management with Boll Weevil Eradication (MOPM-BWE)-- includes eradiction of the boll weevil as a major component. MOPM practices for the control of other insects would be in place during and following eradication. Extension resources would be at the same level as for MOPM.

- Current Insect Control with Boll Weevil Eradication (CIC-BWE) -- also would include eradication of the boll weevil but eradication would supplement current practices. There are no provisions for additional staffing or funding of extension programs prior to, during or following eradication.

Cotton Insect Management Programs:

- Current Insect Control (CIC) -- is identical to the Delphi CIC option.

- Optimum Pest Management with Continuing Incentive Payments for Boll Weevil Management (OPM-I) -- assumes additional extension personnel and support in all subregions. Further assumes that effective areawide diapause and/or pin head square control is practiced (on same acreage as for Delphi OPM option) wherever that is an appropriate technology, and that growers would receive full reimbursement for the cost of diapause and pinhead square treatments. In all areas where the diapause strategy could not be implemented or where it is not needed, the equivalent of the Delphi MOPM option would be in effect.

- Optimum Pest Management with Phased Incentive Payments for Boll Weevil Management (OPM-PI) -- includes the same program components including personnel and funds as OPM-I except that incentive payments for diapause and pinhead square

treatments would be phased out over time. If the required acreage for an effective diapause/pinhead square strategy could not be maintained after payments are phased out, the MOPM option would be implemented.

- Optimum Pest Management with No Incentive Payments for Boll Weevil Management (OPM-NI) -- is the same as OPM-I with the exception that no reimbursements to producers would be made for diapause or pinhead square treatments. If the required level of acreage could not be reached, the MOPM option would be established and the diapause/pinhead square technology would not be implemented on an areawide basis.

- Optimum Pest Management with No Incentive Payments and with Boll Weevil Eradication (OPM-NI-BWE) -- is identical to the Delphi MOPM-BWE option.

- Current Insect Control with Boll Weevil Eradication (CIC-BWE) -- is identical to the Delphi CIC-BWE option.

Detailed program definitions are available in Appendix E: Program Definitions and Public Costs.

Table 1 (page 20) 1/ shows the absolute value of calculations made from Delphi data regarding average number of insecticide applications, average per acre cost of insect control and cotton yield by subregion and management option. To derive an indication of the estimated impact on a particular item of a new management option, comparisons should be made against the baseline CIC estimate.

MOPM Estimates

Estimated impacts of the addition of Extension input vary across subregions. MOPM is projected to reduce average per acre insecticide use by as much as one-tenth of an application per year in Southwest Georgia to a maximum of 3.2 applications in the Winter Garden area of East Texas. However, in five of the 30 subregions, MOPM is estimated to result in slight increases in average insecticide use. A change from CIC to MOPM can result either in a net increase or net decrease in the number of applications made, depending upon whether the current pattern of use is seen as one of overutilization or underutilization of insecticides. The fact that a net reduction was projected for the majority of subregions suggests that panel members generally viewed CIC as employing more than the optimal number of applications and also that they believed increased Extension personnel would be effective in improving the timing and other aspects of current insecticide use. Projected impacts of MOPM on costs exhibited the same trend due to their relatively direct relationship with the number of applications.

The estimated effect of MOPM on yield is positive for every subregion and ranges from an increase in average lint yield per acre of from two pounds in the Mississippi Delta to 36 pounds in Southwest Georgia. These yield increases are judged to be the result of an increased rate of information and technology transfer to growers--one larger than is possible given current levels of Extension and other educational and consultant resources. The yield estimates for MOPM reflect not only the impacts of better transfer of information on boll weevil control but also clearly incorporate the effects of better management of all cotton insect pests. They also may reflect panel members' beliefs that additional Extension education would result in better overall management of the cotton crop. This could include extension of advice on fertilization, irrigation and crop

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1/ All tables and figures are shown at the end of this section.

rotation schedules, weed control and other management practices peripherally related to insect control. However, the projected yield increases are chiefly due to perceived improvements in cotton insect management. (See Attachment F for detailed statements of rationale.)

OPM Estimates

The estimated impacts of OPM on insecticide use vary widely across subregions. In roughly half of the subregions, implementation of OPM is projected to result in an increase in the average number of insecticide applications made per acre. The primary reason for the increase is the requirement under OPM that diapause and/or overwinter treatments be made on sufficient acreage to prevent the need for most in-season treatment of boll weevils. As shown in Table 3, the Delphi estimated average number of diapause/overwinter treatments necessitated by that requirement ranges from 1.3 to 3.7 applications per acre treated in that manner. It is the stated opinion of experts in Regions A and B, where OPM generally was estimated to increase insecticide use, that diapause treatments would not be completely offset by a reduction in in-season applications. Diapause control cannot accurately account for low infestation years. It is a preventative rather than a prescriptive strategy. In a number of subregions it can reduce in-season treatments, but not, under normal conditions, by enough to compensate for the number of preventative treatments required. Over most of Regions C, D, and E, where the required per acre number of diapause or overwinter treatments is lower than in the Southeast, OPM is projected to decrease the total number of applications from that observed under CIC. The degree of reduction in use for these subregions is similar to that estimated for MOPM. This suggests that the reduction may be attributable to improved management and that diapause/overwinter treatment can be approximately offset by reduced in-season use of insecticides. Estimated insect control costs generally move in the same direction, from CIC, as insecticide use. However, when increasing, their proportional increase is less and when decreasing their proportional decrease is greater than that observed for insecticide use. In other words, OPM costs per application are less than CIC costs per application. This is due to the fact that diapause control is inexpensive relative to in-season control. The OPM cost figures in Table 1 include per acre costs of diapause and/or overwinter treatment. Table 2 delineates these OPM costs into their area-wide and non-diapause (non-overwinter) components. Subsequent tables that include insect control costs across all management options show only those OPM costs not associated with diapause and/or overwinter control.

Yield change estimates for OPM are positive in all subregions. The projected OPM yields are slightly greater than or equal to those estimated for MOPM. Since the only difference between those two options is the assumed existence of effective area-wide control under OPM, equality of MOPM and OPM yield estimates suggests panelists believe that well managed in-season treatment for weevils can be as effective over the long run as area-wide preventative treatment. For subregions that have projected OPM yields higher than MOPM yields it is implied that area-wide control would be more effective. (See Attachment F for detailed statements.)

CIC-BWE Estimates

Eradication of the boll weevil in the absence of increased Extension input, CIC-BWE, is projected to have a greater impact on insecticide use and insect control costs than either MOPM or OPM, in almost every subregion considered. With the exception of two subregions in Mississippi where estimated CIC-BWE insecticide use and costs are roughly equal to those estimated for MOPM or OPM, projected insecticide use and associated costs are lower under CIC-BWE than

under either optimum pest management option. This is because under eradication there is no need for any treatment, whether in-season or preventative, against boll weevils. Worm treatments also are reduced due to better conservation of natural enemies. The average estimated reduction in insecticide use attributed to CIC-BWE is 1.5 applications per acre, per year, and ranges from a reduction of .3 applications in Northern Alabama to 5.9 applications in the Central River Bottom area of Texas.

The estimated effect of CIC-BWE on cotton lint yield is positive, compared with CIC, in all subregions, and ranges from an estimated increase of two pounds of lint per acre in Tennessee, the Mississippi Delta, and Northeast Mississippi, to 75 pounds per acre on dryland in the Lower Rio Grande. The projected yield increase attributed to CIC-BWE is less than or equal to that estimated to occur under OPM in every Delphi region except East Texas. Reasons given to explain this result focus on the fact that the CIC-BWE option increases yield only in relation to elimination of the weevil, where greater opportunity exists under MOPM and OPM to increase yields through better management of all insect pests and other crop production activities. Statements of rationale (Attachment F) also include the observation that in many areas the boll weevil is not generally the key or limiting insect pest on cotton. It is stated that increases in manpower and education could reduce yield losses associated with pests that have a greater impact on yield than do weevils.

MOPM-BWE Estimates

Within the static framework under which Delphi estimates were collected, the MOPM-BWE option has estimated producers' cost and yield benefits that are superior to those projected for any of the other four options. Insecticide use under MOPM-BWE has an estimated average value that is 1.6 applications per acre less than CIC. Cost reductions under MORM-BWE average $7.87 per acre over the boll weevil infested portion of the cotton belt. Estimated yield increases under MOPM-BWE range from two pounds of lint per acre in the Mississippi Delta to 85 pounds per acre on Lower Rio Grande dryland. The primary rationale for the superiority of the MOPM-BWE option is that it combines the advantageous effects on costs and yields of both eradication and increased Extension input. (See Attachment F for detailed statements.)

Estimated Impact of Additions to Extension

The difference between CIC-BWE yield and MOPM-BWE yield reflects the yield benefit projected to result from increased Extension input to a system that has no boll weevils. The difference between CIC yield and MOPM yield reflects the projected benefit of increased Extension input under the current boll weevil situation. It is useful to note that, in almost every subregion, the estimated yield increase, from CIC, attributed to MOPM is greater than the difference between estimated yields for CIC-BWE and MOPM-BWE. In other words, MOPM is generally projected to have a greater positive impact on yield in the presence of boll weevils than in the absence of boll weevils. On average, over the boll weevil infested portion of the cotton belt, the estimated yield impact of increased Extension input under eradication (MOPM-BWE yield minus CIC-BWE yield) is 60 percent less than that estimated for the addition of Extension input under current conditions (MOPM yield minus CIC yield). The rationale provided for this

observation is that under current conditions where a boll weevil problem does exist, there is greater opportunity for improved management to positively impact yield. If weevils are assumed to be eradicated, baseline yield is greater than that under CIC, the difference between baseline and maximum attainable yield is less, and hence the incremental benefit of improved management cannot be as great as when one starts from the lower base.

Boll Weevil Control Under OPM

Table 3 shows the boll weevil control actions that average Delphi responses indicate would occur under a fully effective beltwide OPM program. The criterion for full effectiveness is that diapause and/or overwinter treatments are made in sufficient number and over sufficient acreage to prevent the need for in-season treatment of weevils on 90 percent of a subregion's total cotton acreage. Note that in many subregions effective OPM would include some in-season treatments for weevils. The information presented in Table 3 may be used to indicate the relative severity of the boll weevil problem experienced in various subregions. It suggests that boll weevil problems are most severe in Southwest Georgia and least troublesome in the Delta subregions and portions of West Texas and Oklahoma. The treatment patterns described in Table 3 are restricted to actions targeted against boll weevils only. It does not show Delphi estimates of the acreage treated or number of applications simultaneously made against two or more insect targets that may include boll weevils, e.g., the weevil-worm complex.

Standard Deviation of Estimates

Tables 4 and 5 give the standard deviations associated with each subregional Delphi estimate of average insect control cost and lint yield by management option. These measures of dispersion were calculated using standard methods of statistical analysis, but their meaning deserves special interpretation within the context of the Delphi.

They reflect the degree of variation in the subjective judgements of the panel members. If we assume that Delphi responses follow a normal distribution, 68 percent of all panel members' responses regarding a cost or yield estimate should fall within a range defined by the statistical mean plus and minus one standard deviation. For example, from Table 5 it may be implied that approximately two-thirds of Region A's panel members judged subregion 1 and 2 average cotton lint yields under OPM as a value lying between 418.5 (one standard deviation below the mean of 429) and 439.5 (one standard deviation above the mean) pounds per acre. A standard deviation equaling zero indicates that all panel members were in perfect agreement regarding the average estimate. Or, in other words, they all gave the same final response regarding insecticide use or yield under a given mangement option. A non-zero standard deviation indicates that no strict concensus was reached among Delphi regional panelists. A high standard deviation suggests that opinions varied greatly across panel members. Examination of Tables 4 and 5 shows that, in general, Region D's panel experienced the greatest degree of variation in the opinions of its individual members. This is especially true for Region D estimates of yields under alternative management options. For example, although the statistical mean of panel members' judgements of subregion 24's yield under MOPM equals 456 pounds per acre, the variation in response to requests for that estimate was so great as to indicate only that the most reliable judgement has a 68 percent chance of lying in the range of between 389 and 523 pounds per acre. Region E's panel represents the opposite in a spectrum of variance of opinion. It's panel members agreed perfectly on

a single yield estimate for each subregional management option. The standard deviations shown in Tables 4 and 5 are, in many cases, significantly lower than those observed for first and second round averages.

Interregional Differences

Table 6 summarizes final Delphi estimates in terms of the absolute deviation of insecticide application numbers, insect control costs, and lint yields under each proposed beltwide program option from that observed under the current pattern of cotton insect control. This table is especially useful for comparing interregional farm level impacts estimated by the Delphi panels.

The projected types and magnitudes of farm level impacts of a change in boll weevil/cotton insect management option vary significantly across Delphi subregions. Differences in the patterns of projected impacts are explained by differences among subregions in such factors as: the absolute severity of boll weevil problems; the severity of boll weevil relative to other pest problems; weather patterns; farm size; cotton production systems; and the current availability and quality of Extension and private pest management services and programs. One would expect to see greater cost reductions and yield increases attributed to better control of the boll weevil in regions where its damage is most severe than in regions where it is a more minor pest. And, in fact, Region A's estimates reflect the fact that, relative to Regions B and C, the Southeast does experience a more severe boll weevil problem. However, Regions A, B, and C also experience significant problems with a range of other insect pests. The boll weevil, even in areas where it is most abundant, may not be the only key insect pest in these regions. Alternatively, Delphi panel member rationale statements (Attachment F) indicate that in large areas of East Texas the boll weevil is the key or limiting insect pest. This interregional difference in pest status may be reflected in the observation that for Regions A, B, and C, greater incremental yield increases are estimated for a change from CIC to MOPM than from CIC to CIC-BWE, where in Regions D and E, the opposite relationship holds. This suggests that where the relative importance of boll weevil is slight, improved mangement of other key insect pests could have a greater impact on production than would eradication of the weevil. Alternatively, where boll weevil is the key pest, its eradication could impact production more than its improved management would. Projected yield increases, in general, are of greater magnitude in the more western subregions than in the Mid-south and Southeast. Region D panel members explain this (in Attachment F) by the fact that on a significant proportion of acreage in their region, growers currently produce low yields as a result of no or inadequate insect control. In general, each subregional yield change projection also is based on panel members' judgements of the expected effectiveness of new information and technology transfer. In subregions characterized by a large number of smaller cotton farms, technology transfer may be less efficient than in areas where average farm size is large. Subregions that currently have low levels of Extension and private pest management resource availability stand to gain more from increased input than do subregions that already possess well established, far-reaching, public pest management programs and/or good availability of private consultant services. All of these, and other subregional differences should be considered when making interregional comparisons of the Delphi data sets.

Costs and Yields for OPM Incentive Programs

Delphi panel members were asked to describe OPM on their questionnaires in terms of the acre coverage and number of diapause and/or pin head square treatments that would be required for an effective program, i.e. a program that would prevent in-season treatment for weevils prior to treatment for Heliothis on at least 90 percent of all acreage in a subregion. The Delphi OPM estimates are independent of any consideration of alternative incentives programs. However, because those estimates reflect the requirements of effective area-wide control, they were used to define the insecticide use and yield parameters of the full incentives OPM program option. Calculations of insecticide use, direct costs, and cotton yields under full incentives OPM were made in the manner described in the above sections using Delphi OPM estimates.

During the third round of the Delphi process, panel members were polled to determine their best judgements of the grower participation rate expected in each subregion given a "phased incentives" and a "no incentives" OPM program. They were asked to project the expected acreage covered in the fifth year of the phased and no incentives options. Attachment H shows the average of responses to this question, by subregion. These acreage rate of participation figures were compared with the BET estimates of required participation rates. If the projected participation rate was too low to facilitate effective OPM in any area of the subregion, then the MOPM option's results were used to reflect the impacts of the phased or no incentives OPM option. If projected participation was adequate in part, but not all of the subregional area, then a weighted average of Delphi OPM and MOPM estimates for farmer insecticide costs and yield changes was made on the basis of the proportion of acreage using each option. And, if projected participation rate indicates that effective OPM would be possible across the entire subregion, then the OPM estimate was used without modification.

Table 7 shows the results of calculations weighting effective OPM, and MOPM to reflect the insect control cost and lint yield expectations of the Delphi panelists under each of the three alternative OPM incentives programs. Under full incentives, OPM diapause and/or overwinter control costs are not reflected in producers' weighted average costs per acre. Diapause and/or overwinter control costs are, however, included in the producer cost estimates shown for OPM with phased incentives and with no incentives, to the extent that those practices would be utilized.

Aggregated Results

Tables 8 and 9 and Figures 2 and 3 summarize aggregated final Delphi results. Table 8 and Figure 2 present results in terms of Delphi options. Table 9 and Figure 3 show the results of Delphi options converted to reflect the impacts by bollweevil/cotton insect management program. They illustrate the magnitude of differences in insecticide use, cost and cotton lint production indicated by an aggregation of Delphi subregional estimates to regional and beltwide levels. Although interesting and illustrative, these figures require careful interpretation. They do not show final impacts of a change from current conditions to a different beltwide cotton insect management program. Each subregional estimate of a change in insecticide use or yield was made under the assumption that cotton acreage would remain constant. The Delphi estimates were made to reflect average farm level changes only within a particular subregion. Simple aggregation of farm level estimates cannot determine the final, regional or beltwide impacts of a change in boll weevil/cotton insect management. For that reason the National Econometric Cotton Model was designed to utilize the subregional Delphi estimates in evaluating the national impacts of alternative management programs.

Table 1. Delphi summary statistics for average number of insecticide applications, average cotton insect control cost and lint yield per acre, by subregion and management option after full implementation

Region and Subregion	Management Option	Avg. no. applications per acre	Avg. insect control cost per acre 1/	Avg. pounds cotton lint yield per acre
Region A				
1 & 2 - North Carolina, North plus Virginia	CIC	7.4	$44.95	409
	MOPM	6.5	41.30	429
	OPM	7.6	45.62	429
	CIC-BWE	5.1	35.68	423
	MOPM-BWE	4.8	33.77	433
3 - North Carolina, South	CIC	8.7	$52.81	422
	MOPM	8.3	49.49	438
	OPM	10.4	58.74	438
	CIC-BWE	6.8	46.37	431
	MOPM-BWE	7.3	49.31	443
5 - South Carolina, Coastal Plain	CIC	10.4	$68.27	424
	MOPM	11.7	73.92	449
	OPM	12.3	71.46	449
	CIC-BWE	8.8	62.82	433
	MOPM-BWE	8.5	60.51	454
4,6 & 7 - South Carolina, Piedmont, Georgia, Piedmont, and North Carolina, Piedmont	CIC	6.5	$40.18	340
	MOPM	7.5	45.30	367
	OPM	9.2	52.80	367
	CIC-BWE	4.4	29.45	358
	MOPM-BWE	4.8	32.78	375
8 - Georgia, East	CIC	12.7	$86.28	386
	MOPM	12.1	79.20	413
	OPM	14.0	90.17	413
	CIC-BWE	8.2	64.47	402
	MOPM-BWE	9.1	66.38	420
9 - Georgia, Southwest	CIC	13.7	$92.36	471
	MOPM	13.6	88.95	506
	OPM	14.5	89.43	506
	CIC-BWE	10.5	79.50	493
	MOPM-BWE	10.0	74.61	515
10 - Alabama, North	CIC	6.7	$43.97	436
	MOPM	6.7	43.94	446
	OPM	2/	2/	2/
	CIC-BWE	6.4	43.72	440
	MOPM-BWE	6.3	38.92	449

Table 1. con't

Region and Subregion	Management Option	Avg. no. applications per acre	Avg. insect control cost per acre 1/	Avg. pounds cotton lint yield per acre
11 - Alabama, South	CIC	12.3	$81.18	432
	MOPM	11.2	76.25	443
	OPM	12.3	81.40	443
	CIC-BWE	9.1	64.83	442
	MOPM-BWE	7.3	50.27	450
Region B	CIC	3.0	$12.64	453
	MOPM	2.1	9.60	456
12 & 13 - Tennessee	OPM	3.1	12.32	456
	CIC-BWE	0.7	3.16	456
	MOPM-BWE	1.0	4.50	459
14 - Missouri	CIC	0.9	$ 3.11	459
	MOPM	1.7	5.65	464
	OPM	1.9	6.34	464
	CIC-BWE	.4	1.35	464
	MOPM-BWE	1.2	4.22	467
19 - Arkansas, Northeast	CIC	1.0	$ 3.21	433
	MOPM	1.3	5.11	438
	OPM	1.5	5.68	438
	CIC-BWE	.5	2.07	436
	MOPM-BWE	.9	3.86	439
20 - Arkansas, Southeast	CIC	4.4	$24.72	512
	MOPM	3.6	21.61	519
	OPM	5.0	21.82	519
	CIC-BWE	3.0	15.99	517
	MOPM-BWE	3.7	18.45	521
Region C				
15 - Mississippi, Northeast	CIC	7.5	$35.97	433
	MOPM	7.0	32.58	437
	OPM	6.5	31.64	438
	CIC-BWE	5.6	28.56	435
	MOPM-BWE	5.1	25.05	437
16 - Mississippi, North Central	CIC	8.4	$40.42	526
	MOPM	7.8	37.36	531
	OPM	6.9	31.86	531
	CIC-BWE	5.5	30.80	532
	MOPM-BWE	5.2	28.89	534

Table 1. con't

Region and Subregion	Management Option	Avg. no. applications per acre	Avg. insect control cost per acre 1/	Avg. pounds cotton lint yield per acre
17 - Mississippi, Delta	CIC	8.7	$44.83	567
	MOPM	7.8	42.00	569
	OPM	8.2	41.08	569
	CIC-BWE	8.0	42.47	569
	MOPM-BWE	7.8	42.00	569
18 - Mississippi, South	CIC	8.8	$42.91	524
	MOPM	7.9	35.99	530
	OPM	7.1	34.86	530
	CIC-BWE	6.8	35.41	528
	MOPM-BWE	5.7	32.59	530
21 - Louisiana, Northeast	CIC	9.0	$52.00	516
	MOPM	8.5	45.98	525
	OPM	8.1	44.01	525
	CIC-BWE	6.9	42.03	525
	MOPM-BWE	6.3	38.79	527
22 - Louisiana, Red River Valley	CIC	9.0	$55.82	534
	MOPM	8.7	50.74	540
	OPM	9.1	52.06	540
	CIC-BWE	7.1	43.87	540
	MOPM-BWE	6.8	43.11	542
on D				
3 - Lower Rio Grande Irrigated	CIC	7.2	$43.07	474
	MOPM	4.2	23.41	499
	OPM	4.1	21.70	502
	CIC-BWE	2.5	12.77	506
	MOPM-BWE	2.2	11.48	511
40 - Lower Rio Grande Dryland	CIC	5.5	$28.23	445
	MOPM	3.3	15.56	472
	OPM	3.7	17.20	480
	CIC-BWE	1.9	8.25	520
	MOPM-BWE	1.8	7.21	530
24 - Texas, Lower Bend	CIC	3.3	$16.66	434
	MOPM	2.9	13.39	456
	OPM	3.1	14.33	461
	CIC-BWE	0.9	3.40	465
	MOPM-BWE	0.8	3.20	472

Table 1. con't

Region and Subregion	Management Option	Avg. no. applications per acre	Avg. insect control cost per acre 1/	Avg. pounds cotton lint yield per acre
25 - Texas, Upper Bend	CIC	5.7	$25.95	386
	MOPM	5.0	22.71	403
	OPM	4.3	20.77	407
	CIC-BWE	1.9	10.10	414
	MOPM-BWE	1.7	9.16	420
26 - Winter Garden	CIC	7.6	$45.82	526
	MOPM	4.4	21.52	560
	OPM	4.1	18.20	566
	CIC-BWE	2.1	13.92	577
	MOPM-BWE	1.8	11.43	584
27 - Central River Bottom	CIC	8.7	$61.55	474
	MOPM	6.1	40.69	506
	OPM	5.4	32.53	512
	CIC-BWE	2.8	16.91	521
	MOPM-BWE	2.5	14.79	537
28 - Texas Blacklands	CIC	2.4	$ 8.18	239
	MOPM	2.5	7.88	273
	OPM	2.8	8.75	281
	CIC-BWE	1.5	4.09	289
	MOPM-BWE	1.3	3.15	294
Region E				
29 - Texas, Rolling Plains	CIC	0.9	$ 3.40	295
	MOPM	0.2	0.88	324
	OPM	0.8	3.00	329
	CIC-BWE	0.1	0.31	329
	MOPM-BWE	<0.1	0.21	339
30 - Texas, High Plains 3/, 4/	CIC	<0.1	<0.10	339 3/
31 - Upper Concho Basin	CIC	0.8	2.93	343
	MOPM	0.6	2.40	378
	OPM	2/	2/	2/
	CIC-BWE	0.3	0.99	373
	MOPM-BWE	0.6	0.97	383

Table 1. con't

Region and Subregion	Management Option	Avg. no. applications per acre	Avg. insect control cost per acre 1/	Avg. pounds cotton lint yield per acre
32 & 33 - Pecos and El Paso Valleys 4/	CIC	0.8	6.28	530
34 & 35 - Oklahoma 3/	CIC	1.15	6.38	260
	MOPM	1.0	4.38	272
	OPM	1.15 5/	5.23 5/	274 5/
	CIC-BWE	0.45	3.91	276
	MOPM-BWE	0.15	0.63	281

1/ OPM costs include the entire costs of diapause and/or overwinter treatments. The BWE options do not include the farmers' share of eradication costs.

2/ No OPM.

3/ Dryland estimates, Irrigated estimates are equal to Cooke's CIC estimates.

4/ Non boll weevil subregion -- CIC is only option considered.

5/ Personal communication with a single Delphi panelist.

Table 2. Components of total Delphi OPM insect control costs

Region and Subregion	Insect control costs per acre: Diapause and/or over-winter control costs 1/	Insect control costs exclusive of diapause and overwinter treatment	Total costs
	Dollars		
1 & 2 - North Carolina, North plus VA	8.08	37.54	45.62
3 - North Carolina, South	8.88	49.86	58.74
5 - South Carolina, Coastal Plain	11.06	60.40	71.46
4,6, & 7 - SC, GA, NC and Piedmonts	10.58	42.22	52.80
8 - Georgia, East	11.92	78.25	90.17
9 - Georgia, Southwest	12.30	77.13	89.43
10 - Alabama, North	NA	NA	NA
11 - Alabama, South	6.72	74.68	81.40
Region B			
12 & 13 - Tennessee	4.62	7.70	12.32
14 - Missouri	2.05	4.29	6.34
19 - Arkansas, Northeast	1.04	4.64	5.68
20 - Arkansas, Southeast	2.70	19.12	21.82
Region C			
15 - Mississippi, Northeast	4.20	27.44	31.64
16 - Mississippi, North Central	4.47	27.39	31.86
17 - Mississippi, Delta	2.47	38.61	41.08
18 - Mississippi, South	5.73	29.13	34.86
21 - Louisiana, Northeast	7.32	36.69	34.01
22 - Louisiana, Red River Valley	6.43	45.63	52.06

-continued-

Table 2. Components of total Delphi OPM insect control costs

Region and Subregion	Insect control costs per acre: Diapause and/or overwinter control costs 1/	Insect control costs exclusive of diapause and overwinter treatment	Total costs
	Dollars		
Region D			
23 - Lower Rio Grande	4.69	17.01	21.70
40 - Lower Rio Grande, Dryland	4.24	12.96	17.20
24 - Texas, Lower Bend	5.85	8.48	14.33
25 - Texas, Upper Bend	8.73	12.04	20.77
26 - Winter Garden	5.36	12.84	18.20
27 - Central River Bottom	2.67	29.86	32.53
28 - Texas Blacklands	2.74	6.01	8.75
Region E			
29 - Texas, Rolling Plains	2.63	.37	3.00
30 - Texas, High Plains	NA	NA	NA
31 - Upper Concho Basin	NA	NA	NA
32 & 33 - Pecos and El Paso Valleys	NA	NA	NA
34 & 35 - Oklahoma, Dryland 2/	.85	4.38	5.23

1/ Per acre diapause or overwinter control costs were calculated by multiplying the product of the proportion of acres receiving diapause and/or overwinter treatment, times the average number of diapause or overwinter applications made, times the average materials plus treatment cost per diapause or overwinter application.

2/ Personal communication with a single Delphi panelist.

Table 3. Delphi regional descriptions of boll weevil control under effective OPM

Subregion	Boll weevil treatment type(s) 1/	Average percent acreage treated	Average number of applications per treated acre	Ratio of guthion to M.P. use for diapause or over-winter
Region A				
1 & 2 - North Carolina, North plus Virginia	in-season	7.5	0.8	
	diapause	100.0	2.5	70:30
3 - North Carolina, South	in-season	10.0	1.0	
	diapause	100.0	2.9	80:20
5 - South Carolina, Coastal Plain	in-season	17.5	1.3	
	diapause	100.0	3.7	40:60
4,6 & 7 - South Carolina, Piedmont Georgia, Piedmont, and North Carolina, Piedmont	in-season	10.0	1.0	
	diapause	100.0	3.2	55:45
8 - Georgia, East	in-season	7.5	1.1	
	diapause	100.0	3.5	55:45
9 - Georgia, Southwest	in-season	10.0	1.4	
	diapause	100.0	3.7	45:55
10 - Alabama, North	no OPM	N/A	N/A	N/A
11 - Alabama, South	diapause	100.0	2.2	50:50
Region B				
12 & 13 - Tennessee	diapause	51.0	3.0	60:40
14 - Missouri	diapause	30.0	2.4	25:75

Table 3. con't

Subregion	Boll weevil treatment type(s)	Average percent acreage treated	Average number of applications per treated acre	Ratio of guthion to M.P. use for diapause or overwinter
19 - Arkansas, Northeast	diapause	23.0	2.2	20:80
20 - Arkansas, Southeast	diapause	42.0	3.0	25:75
Region C				
15 - Mississippi, Northeast	diapause	79.4	1.9	45:55
16 - Mississippi, North Central	diapause	90.0	1.8	50:50
17 - Mississippi, Delta	diapause	70.0	1.3	50:50
18 - Mississippi, South	diapause	95.7	2.2	40:60
21 - Louisiana, Northeast	diapause	96.9	2.3	45:55
22 - Louisiana, Red River Valley	diapause	95.0	2.0	60:40
Region D				
23 - Lower Rio Grande	overwinter	62.0	2.0	90:10
40 - Lower Rio Grande	in-season	8.75	2.8	
Dryland	overwinter	50.0	2.2	100.0
24 - Texas, Lower Bend	in-season	8.0	2.6	
	overwinter	68.75	2.1	95:5
25 - Texas, Upper Bend	in-season	12.0	2.8	2/
	diapause	42.0	1.9	3/
	overwinter	71.67	2.0	

Table 3. con't

Subregion	Boll weevil treatment type(s)	Average percent acreage treated	Average number of applications per treated acre	Ratio of guthion to M.P. use for diapause or overwinter
26 - Winter Garden	overwinter	82.5	1.8	65:35
27 - Central River Bottom	overwinter	46.4	1.55	60:40
28 - Texas Blacklands	in-season	7.5	2.2	
	overwinter	60.0	1.7	4/
Region E				
29 - Texas, Rolling Plains	in-season	5.0	.5	70:30
	diapause	25.0	2.4	20:80
	overwinter	15.0	.7	75:25
30 - Texas, High Plains	No OPM Strategy			
31 - Upper Concho Basin	No OPM Strategy			
32 & 33 - Pecos and El Paso Valleys	No OPM Strategy			
34 & 35 - Oklahoma, dryland	in-season	15.0	1.8	45:55 5/
	diapause	10.7	2.0	5:95 5/

1/ Represents control actions taken against the "boll weevil only" target pest category. In-season treatment shown under this column does not include treatment made to the "weevils and worms" insect complex.
2/ 100 percent malathion use.
3/ Sixty-five percent of total use is accounted for by guthion; twenty-five percent by methyl parathion, and 100 percent by other materials.
4/ Five percent of total use is accounted for by guthion; 35 percent by methyl parathion, and 60 percent by other materials, including imidan and malathion.
5/ Guthion: malathion, parathion, and toxaphene/M.P.

Table 4. Average estimate and standard deviation of responses for cost of insect control by subregion in dollars per acre after full implementation 1/

Region and Subregion	CIC		MOPM		OPM		CIC-BWE		MOPM-BWE	
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
Region A										
1 & 2 - North Carolina North plus VA	$44.95	(13.01)	$41.30	(5.17)	$37.54	(7.97)	$35.68	(9.11)	$33.77	(7.39)
3 - North Carolina, South	52.81	(5.31)	49.49	(13.93)	49.86	(13.45)	46.37	(15.24)	49.31	(12.70)
5 - South Carolina, Coastal Plain	68.27	(11.72)	73.92	(29.41)	60.40	(20.05)	62.82	(19.74)	60.51	(11.08)
4,6 & 7 - SC, GA, NC and Piedmonts	40.18	(3.36)	45.30	(16.09)	42.22	(13.56)	29.45	(8.49)	32.78	(9.77)
8 - Georgia, East	86.28	(12.35)	79.20	(26.32)	78.25	(11.93)	64.47	(19.38)	66.38	(15.33)
9 - Georgia, Southwest	92.36	(8.74)	88.95	(31.02)	77.13	(8.41)	79.50	(14.75)	74.61	(6.88)
10 - Alabama, North	43.97	(4.40)	43.94	(4.40)	NA		43.72	(4.75)	38.92	(4.00)
11 - Alabama, South	81.18	(8.10)	76.25	(7.63)	74.68	(7.30)	64.83	(6.80)	50.27	(5.00)
Region B										
12 & 13 - Tennessee	12.64	(4.13)	9.60	(3.21)	7.70	(3.84)	3.16	(3.89)	4.50	(0.67)
14 - Missouri	3.11	(1.08)	5.65	(1.11)	4.29	(0.75)	1.35	(0.54)	4.22	(1.48)
19 - Arkansas, NE	3.21	(0.37)	5.11	(0.86)	4.64	(0.47)	2.07	(0.40)	3.86	(0.99)
20 - Arkansas, SE	24.72	(0.79)	21.61	(4.72)	19.12	(4.68)	15.99	(4.79)	18.45	(4.62)

Table 4. con't

Region and Subregion	CIC Avg.	CIC Std. Dev.	MOPM Avg.	MOPM Std. Dev.	OPM Avg.	OPM Std. Dev.	CIC-BWE Avg.	CIC-BWE Std. Dev.	MOPM-BWE Avg.	MOPM-BWE Std. Dev.
Region C										
15 - Mississippi, Northeast	$35.97	(6.18)	$32.58	(6.31)	$27.44	(6.20)	$28.56	(4.20)	$25.05	(1.19)
16 - Mississippi, North Central	40.42	(7.80)	37.36	(7.65)	27.39	(6.04)	30.80	(5.56)	28.89	(5.33)
17 - Mississippi, Delta	44.83	(10.09)	42.00	(15.86)	38.61	(5.61)	42.47	(6.04)	42.00	(11.91)
18 - Mississippi, South	42.91	(3.97)	35.99	(4.52)	29.13	(3.87)	35.41	(8.81)	32.59	(4.88)
21 - Louisiana, Northeast	52.00	(4.71)	45.98	(4.31)	36.69	(3.11)	42.03	(3.53)	38.79	(3.43)
22 - Louisiansa, Red River Valley	55.82	(8.98)	50.74	(10.71)	45.63	(8.14)	43.87	(7.09)	43.11	(7.13)
Region D										
23 - Lower Rio Grande, Irrigated	43.07	(13.77)	23.41	(13.49)	17.01	(6.12)	12.77	(6.12)	11.48	(3.80)
23 - Lower Rio Grande Dryland	28.23	(9.57)	15.56	(6.56)	13.00	(6.68)	8.25	(1.79)	7.21	(2.67)
24 - Texas, Lower Bend	16.66	(4.65)	13.39	(5.93)	8.48	(5.50)	3.40	(0.85)	3.20	(0.40)
25 - Texas, Upper Bend	25.95	(5.53)	22.71	(8.86)	12.04	(7.45)	10.10	(7.15)	9.16	(6.42)

Table 4. con't

Region and Subregion	CIC		MOPM		OPM		CIC-BWE		MOPM-BWE	
	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
26 - Winter Garden	45.82	(10.90)	21.52	(7.50)	12.84	(3.24)	13.92	(4.27)	11.43	(2.82)
27 - Central River Bottom	61.55	(14.50)	40.69	(26.54)	29.89	(15.72)	16.91	(11.89)	14.79	(9.60)
28 - Texas Blacklands	8.18	(2.13)	7.88	(4.12)	6.01	(3.47)	4.09	(2.25)	3.15	(1.42)
Region E										
29 - Texas, Rolling Plains	3.40	(0.0)	0.88	(0.0)	0.37	(0.0)	0.31	(0.0)	0.21	(0.0)
30 - Texas, High Plains (dryland)	<0.10	(0.0)	NA		NA		NA		NA	
31 - Upper Concho Basin	2.93	(0.0)	2.40	(0.0)	NA		0.99	(0.0)	0.97	(0.0)
32 & 33 - Pecos and El Paso Valleys	6.28	(5.77)	NA		NA		NA		NA	
34 & 35 - Oklahoma (dryland)	6.38	(0.0)	4.38	(1.96)	4.38	(0.0)	3.91	(0.0)	0.63	(0.0)

1/ OPM cost estimates do not include the cost of diapause and/or overwinter treatments. CIC-BWE and MOPM-BWE costs do not include the farmers' share of eradication costs.

Table 5. Average estimate and standard deviation or response for cotton lint yield by subregion and management option, in pounds per acre, after full implementation

Region and Subregion	CIC		MOPM		OPM		CIC-BWE		MOPM-BWE	
	Avg.	Std. Dev.	Avg.	St. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
Region A										
1 & 2 - North Carolina North plus VA	408.8	(8.1)	429.0	(3.0)	429.0	(10.5)	423.5	(8.1)	433.1	(3.4)
3 - North Carolina, South	422.2	(8.5)	438.4	(0.9)	438.4	(11.7)	431.3	(6.4)	443.1	(2.3)
5 - South Carolina, Coastal Plain	424.5	(5.2)	449.3	(0.3)	449.3	(15.2)	432.7	(30.1)	453.9	(4.5)
4,6 & 7 - SC, GA, NC and Piedmonts	339.7	(10.8)	366.6	(5.0)	366.6	(12.5)	358.3	(12.3)	374.8	(9.1)
8 - Georgia, East	386.2	(17.4)	412.7	(10.7)	412.7	(14.7)	402.3	(10.9)	420	(2.5)
9 - Georgia, Southwest	470.6	(12.5)	506.2	(7.7)	506.2	(7.0)	492.6	(14.4)	515.0	(5.5)
10 - Alabama, North	436.5	(4.0)	446.5	(7.0)	NA		440.0	(8.0)	449.4	(8.0)
11 - Alabama, South	432.0	(4.0)	442.8	(6.5)	442.8	(6.5)	442.3	(8.0)	449.8	(8.0)
Region B										
12 & 13 - Tennessee	453.4		456.2		456.2		455.8		458.8	
14 - Missouri	458.9		464.4		464.4		464.1		467.2	
19 - Arkansas, Northeast	433.4		438.5		438.5		436.0		439.2	

Table 5. con't

Region and Subregion	CIC		MOPM		OPM		CIC-BWE		MOPM-BWE	
	Avg.	Std. Dev.	Avg.	St. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
20 - Arkansas, Southeast	511.7		519.5		519.5		516.7		521.0	
Region C										
15 - Mississippi, Northeast	433.1	(0)	437.3	(3.7)	437.6	(4.6)	435.1	(3.5)	437.0	(6.5)
16 - Mississippi, North Central	526.1	(0)	531.3	(3.9)	531.4	(4.7)	532.0	(3.3)	533.9	(5.3)
17 - Mississippi, Delta	567.0	(0)	569.2	(2.3)	569.2	(2.3)	568.8	(1.3)	568.8	(1.3)
18 - Mississippi, South	523.6	(0)	529.6	(4.8)	529.7	(5.8)	528.1	(4.6)	530.2	(6.8)
21 - Louisiana, Northeast	515.9	(0)	524.6	(3.9)	525.2	(4.5)	525.1	(4.3)	526.6	(5.6)
22 - Louisiana, Red River Valley	534.2	(0)	540.0	(2.6)	540.0	(4.0)	539.8	(3.9)	541.9	(5.2)
Region D										
23 - Lower Rio Grande	474.0	(57.8)	499.0	(49.2)	502.0	(52.7)	506.0	(55.8)	511.0	(54.5)
40 - Lower Rio Grande Dryland	445.0	(22.3)	472.0	(28.7)	480.0	(21.9)	520.0	(34.7)	530.0	(31.9)

Table 5. con't

Region and Subregion	CIC		MOPM		OPM		CIC-BWE		MOPM-BWE	
	Avg.	Std. Dev.	Avg.	St. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.	Avg.	Std. Dev.
24 - Texas, Lower Bend	434	(61.7)	456	(67.3)	461	(64.4)	465	(52.2)	472	(53.1)
25 - Texas, Upper Bend	386	(6.7)	403	(11.9)	407	(11.0)	414	(15.3)	420	(20.1)
26 - Winter Garden	526	(40.3)	560	(26.1)	566	(31.6)	577	(29.1)	584	(30.8)
27 - Central River Bottom	474	(30.6)	506	(38.7)	512	(28.9)	521	(16.4)	537	(12.9)
28 - Texas Blacklands	239	(25.3)	273	(23.3)	281	(19.2)	289	(17.8)	294	(25.1)
Region E										
29 - Texas, Rolling Plains	295	(0)	324	(0)	329	(0)	329	(0)	339	(0)
30 - Texas, High Plains, dryland	339	(0)	NA		NA		NA		NA	
31 - Upper Concho Basin	343	(0)	378	(0)	NA		373	(0)	383	(0)
32 & 33 - Pecos and El Paso Valleys	530	(0)	NA		NA		NA		NA	
34 & 35 - Oklahoma dryland	260	(0)	272	(0)	274	(0)	276	(0)	281	(0)

Table 6. Comparison of selected Delphi results within and across regions

Region and Subregion	Actual 1974-78 average acres cotton	Average number of insecticide applications per year: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC &BWE	Change from CIC: MOPM & BWE	Average cost of insecticide materials and application: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC &BWE	Change from CIC: MOPM &BWE	Actual 1969-78 average yield cotton	Average cotton lint yield per acre: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC & BWE	Change from CIC: MOPM & BWE
	(000)						dols.					lbs./ acre					
Region A																	
1&2-NC, North plus VA	27.2	7.4	- .9	+ .2	-2.3	-2.6	$44.95	-3.65	-7.41	-9.27	-11.18	410	409	+20	+20	+15	+24
3-NC, South	36.2	8.7	- .4	+1.7	-1.9	-1.4	52.81	-3.32	-2.95	-6.44	- 3.50	427	422	+16	+16	+ 9	+21
5-SC, Coastal Plain	247.3	10.4	+1.3	+1.9	-1.6	-1.9	68.27	+5.65	-7.87	-5.45	- 7.76	425	424	+25	+25	+ 8	+29
4,6&7-SC,GA and NC Piedmonts	49.4	6.5	+1.0	+2.7	-2.1	-1.7	40.18	+5.12	+2.04	-10.73	- 7.40	343	340	+27	+27	+19	+35
8-GA, East	81.8	12.7	- .6	+1.3	-4.5	-3.6	86.28	-7.08	-8.03	-21.81	-19.90	382	386	+26	+26	+16	+34
9-GA, Southwest	104.5	13.7	- .1	+ .8	-3.2	-3.7	92.36	-3.41	-15.23	-12.86	-17.75	476	471	+36	+36	+22	+44
10-AL, North	249.0	6.7	0	NA	- .3	- .4	43.97	- .03	NA	- .25	- 5.05	446	436	+10	NA	+ 3	+13
11-AL, South	173.9	12.3	- .9	0	-3.2	-5.0	81.18	-4.93	-6.50	-16.35	-30.91	439	432	+11	+11	+10	+18
Region B																	
12&13-TN	318.1	3.0	- .9	+ .1	-2.3	-2.0	12.64	-3.04	-4.12	- 9.48	- 8.14	452	453	+3	+3	+2	+ 5
14-MO	244.8	.9	+ .8	+1.1	- .4	+ .1	3.11	+2.54	+1.18	- 1.76	+ 1.11	465	459	+5	+5	+5	+ 8
19-AR, Northeast	414.1	1.0	+ .3	+ .5	- .4	- .3	3.21	+1.90	+1.43	- 1.14	+ .65	436	433	+5	+5	+3	+ 6
20-AR, Southeast	451.4	4.4	- .8	+ .6	-1.4	- .7	24.72	-3.11	-5.60	- 8.73	- 6.27	518	512	+8	+8	+5	+ 9

Table 6. con't

Region and Subregion	Actual 1974-78 average acres cotton	Average number of insecticide applications per year: Total CIC	Change from CIC: MOPM	OPM	CIC & BWE	MOPM & BWE	Average cost of insecticide materials and application: Total CIC	Change from CIC: MOPM	OPM	CIC & BWE	MOPM & BWE	Actual 1969-78 average yield cotton	Average cotton lint yield per acre: Total CIC	Change from CIC: MOPM	OPM	CIC & BWE	MOPM & BWE
	(000)						dols.					lbs./ acre					
Region C																	
15-MS, Northeast	88.1	7.5	- .5	-1.0	-1.9	-2.4	$35.97	- 3.39	- 8.53	- 7.41	-10.92	435	433	+ 4	+ 4	+ 2	+ 4
16-MS, North Central	194.2	8.4	- .6	-1.5	-2.9	-3.2	40.42	- 3.06	-13.03	- 9.62	-11.53	530	526	+ 5	+ 5	+ 6	+ 8
17-MS, Delta	871.6	8.7	- .9	- .5	- .7	- .9	44.83	- 2.83	- 6.22	- 2.35	- 2.83	572	567	+ 2	+ 2	+ 2	+ 2
18-MS, South	203.1	8.8	- .9	-1.7	-2.0	-3.1	42.91	- 6.92	-13.78	- 7.50	-10.32	525	524	+ 6	+ 6	+ 4	+ 7
21-LA, Northeast	427.2	9.0	- .5	- .8	-2.1	-2.7	52.00	- 6.02	-15.31	- 9.97	-13.21	512	516	+ 9	+ 9	+ 9	+11
22-LA, Red River Valley	76.4	9.05	- .3	+ .1	-1.9	-2.2	55.82	- 5.08	-10.19	-11.95	-12.70	545	534	+ 6	+ 6	+ 6	+ 8
Region D																	
23-Lower Rio Grande, Irrigated	166.6	7.2	-3.0	-3.1	-4.7	-5.0	43.07	-19.66	-26.06	-30.30	-31.59	450 (Average for 23 & 40)	474	+25	+28	+32	+37
40-Lower Rio Grande Dryland	106.5	5.5	-2.2	-1.8	-3.6	-3.7	28.23	-12.67	-15.27	-19.98	-21.02		445	+27	+35	+75	+85
24-TX, Lower Bend	115.5	3.3	- .4	- .2	-2.4	-2.5	16.66	- 3.27	- 8.18	-13.26	-13.46	208	434	+22	+27	+31	+38
25-TX, Upper Bend	78.7	5.7	- .7	-1.4	-3.8	-4.0	25.95	- 3.24	-13.91	-15.85	-16.79	385	386	+17	+21	+28	+34
26-Winter Garden	17.6	7.6	-3.2	-3.5	-5.5	-5.8	45.82	-24.30	-32.98	-31.90	-34.39	493	526	+34	+40	+51	+58

Table 6. con't

Region and Subregion	Actual 1974-78 average acres cotton	Average number of insecticide applications per year: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC &BWE	Change from CIC: MOPM & BWE	Average cost of insecticide materials and application: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC &BWE	Change from CIC: MOPM &BWE	Actual 1969-78 average yield cotton	Average cotton lint yield per acre: Total CIC	Change from CIC: MOPM	Change from CIC: OPM	Change from CIC: CIC & BWE	Change from CIC: MOPM & BWE
	(000)						dols.					lbs./acre					
27-Central River Bottom	43.0	8.7	-2.6	-3.3	-5.9	-6.2	61.55	-20.86	-31.69	-44.64	-46.76	492	474	+32	+38	+47	+63
28-TX, Blacklands	428.8	2.4	+ .1	+ .4	- .9	-1.1	8.18	- .30	- 2.17	- 4.09	- 5.03	226	239	+34	+42	+50	+55
Region E																	
29-TX, Rolling Plains	1,104.8	.9	- .7	- .1	- .8	- .9	3.40	- 2.52	- 3.03	- 3.09	- 3.19	295	295	+29	+34	+34	+44
30-TX, High (dryland) Plains 4/	1,271.3	< .1	3/	3/	3/	3/	< .01	3/	3/	3/	3/		339 4/	3/	3/	3/	3/
Total	2,763.6											361					
31-Upper Concho Basin	117.5	.8	- .15	2/	- .5	+ .2	2.93	- .53	2/	- 1.94	- 1.96	343	343	+35	2/	+30	+40
32&33-Pecos & El Paso Valleys	53.6	.8	3/	3/	3/	3/	6.28	3/	3/	3/	3/	544	530	3/	3/	3/	3/
34&35-OK 4/(dryland)	328.3	1.15	- .2	- .2	- .7	-1.0	6.38	- 2.00	- 2.00	-2.47	- 5.75		260 4/	+12	+14	+16	+21
Total	406.1											301					

1/ OPM costs to the producer do not include the costs of diapause and/or overwinter treatments. Under full incentives OPM, these control actions would be publically funded.

2/ OPM unnecessary or infeasible. MOPM estimates apply.

3/ Non boll weevil subregion -- CIC is only option considered.

4/ Estimates are for dryland acreage only. Irrigated acreage estimates are assumed equal to Cooke's data.

Table 7. Final Delphi estimates of producers' average insect control costs and cotton lint yields, by subregion and OPM incentives option, after full implementation

Region and Subregion	OPM with full incentives			OPM with phased incentives			OPM with no incentives		
	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/
Region A									
1 & 2 - North Carolina, North plus VA	100:0	$37.54	429.0	80:20	$44.76	429.0	50:50	43.46	429.0
3 - North Carolina, South	100:0	49.86	438.4	0:100	49.49	438.4	0:100	49.49	438.4
5 - South Carolina, Coastal Plain	100:0	60.40	449.3	0:100	73.92	449.3	0:100	73.92	449.3
4,6 & 7 - SC, GA, and NC Piedmonts	100:0	42.22	366.6	0:100	45.30	366.6	0:100	45.30	366.6
8 - Georgia, East	100:0	78.25	412.7	0:100	79.20	412.7	0:100	79.20	412.7
9 - Georgia, Southwest	100:0	77.13	506.2	0:100	88.95	506.2	0:100	88.95	506.2
11 - Alabama, South	100:0	74.68	442.8	0:100	76.25	442.8	0:100	76.25	442.8
Region B									
12 & 13 - Tennessee	100:0	7.70	456.2	87:13	11.97	456.2	83:17	11.86	456.2
14 - Missouri	100:0	4.29	464.4	92:8	6.28	464.4	89:11	6.26	464.4
19 - Arkansas, Northeast	100:0	4.64	438.5	96:4	5.66	438.5	95:5	5.65	438.5
20 - Arkansas, Southeast	100:0	19.12	519.5	0:100	21.61	519.5	0:100	21.61	519.5

Table 7. con't

Region and Subregion	OPM with full incentives			OPM with phased incentives			OPM with no incentives		
	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/
Region C									
15 - Mississippi, NE	100:0	27.44	437.6	0:100	32.58	437.3	0:100	32.58	437.3
16 - Mississippi, North Central	100:0	27.39	531.4	0:100	37.36	531.3	0:100	37.36	531.3
17 - Mississippi, Delta	100:0	38.61	569.2	0:100	42.00	569.2	0:100	42.00	569.2
18 - Mississippi, South	100:0	29.13	529.6	0:100	35.99	529.6	0:100	35.99	529.6
21 - Louisiana, Northeast	100:0	36.69	525.2	0:100	45.98	524.6	0:100	45.98	524.6
22 - Louisiana, Red River Valley	100:0	45.63	540.0	0:100	50.74	540.0	0:100	50.74	540.0
Region D									
23 - Lower Rio Grande	100:0	17.01	502	0:100	23.41	499	0:100	23.41	499
40 - Lower Rio Grande Dryland	100:0	12.96	480	0:100	15.56	472	0:100	15.56	472
24 - Texas, Lower Bend	100:0	8.48	461	0:100	13.39	456	0:100	13.39	456
25 - Texas, Upper Bend	100:0	12.04	407	0:100	22.71	403	0:100	22.71	403
26 - Winter Garden	100:0	12.84	566	0:100	21.52	560	0:100	21.52	560
27 - Central River Bottom	100:0	29.86	512	0:100	40.69	506	0:100	40.69	506

Table 7. con't

Region and Subregion	OPM with full incentives			OPM with phased incentives			OPM with no incentives		
	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/	Ratio of acres in effective OPM: acres in MOPM	wtd. avg. cost per acre 1/	wtd. avg. cotton lint yield per acre 1/
28 - Texas Blacklands	100:0	6.01	281	0:100	7.88	273	0:100	7.88	273
Region E									
29 - Texas, Rolling Plains	100:0	.37	329	0:100	0.88	324	0:100	0.88	324
34,35-Oklahoma Rolling Plains, dryland 2/	11:89	4.38	272	11:89	4.38	272	0:100	4.38	272

1/ Weights are based on the proportion of acreage in each of OPM and MOPM within a subregion. See Attachment H for determination of proportions of acreages by subregion. Costs include the farmers' share of diapause and/or overwinter treatments.

2/ Information obtained partly from a single Delphi panelist.

Table 8: Delphi estimated total insecticide use, insect control costs and cotton production, by management option after full implementation 1/

Region	Management option	Average number of applications, per acre	Acre treatments w/ insecticides (mil. acre treatments)	Total producers' insect control costs 2/ (mil. dols.)	Total cotton lint production (mil. lbs.)
Region A	CIC	10.0	8.8	58	377
Virginia, N. Carolina,	MOPM	10.0	8.7	57	394
S. Carolina, Georgia,	OPM	11.2	9.7	53	394
and Alabama	CIC-BWE	8.0	7.0	50	386
	MOPM-BWE	7.6	6.6	46	398
Region B					
Tennessee, Missouri,	CIC	2.5	3.6	18	678
and Arkansas	MOPM	2.3	3.3	17	686
	OPM	3.1	4.4	14	686
	CIC-BWE	1.4	2.0	8	686
	MOPM-BWE	1.9	2.7	13	689
Region C					
Mississippi and	CIC	8.7	16.2	85	1,002
Louisiana	MOPM	8.0	14.8	78	1,011
	OPM	7.9	14.7	66	1,011
	CIC-BWE	7.2	13.4	74	1,010
	MOPM-BWE	6.8	12.6	71	1,012
Region D					
East Texas	CIC	4.2	4.1	20	337
	MOPM	3.3	3.1	14	365
	OPM	3.4	3.3	10	375
	CIC-BWE	1.7	1.6	7	375
	MOPM-BWE	1.5	1.5	6	390
Region E					
Oklahoma, and boll	CIC	1.2	1.9	10	496
weevil infested	MOPM	0.7	1.1	4	536
areas of W. Texas 3/	OPM	1.1	1.8	2	541
	CIC-BWE	0.4	0.6	3	542
	MOPM-BWE	0.3	0.5	2	556
Total, specified areas	CIC	5.1	35	191	2,890
	MOPM	4.6	31	169	2,991
	OPM	5.0	34	147	3,007
	CIC-BWE	3.6	25	144	3,006
	MOPM-BWE	3.5	24	137	3,045

1/ Assumes undiscounted constant dollars and 1974-78 average cotton acreage.
2/ OPM costs do not include costs of diapause and/or overwinter control. Also, farmers' share of eradication costs are not included.
3/ Excludes subregions 30, 32 and 33, where there is no boll weevil problem.

Table 9. Delphi estimated total insecticide use, producers' insect control costs, and cotton lint production, by boll weevil/cotton insect management program, given full implementation 1/

Region	Management option	Average number of applications, per acre	Acre treatments w/ insecticides (mil. acre treatments)	Total producers' insect control costs 2/ (mil. dols.)	Total cotton lint production (mil. lbs.)
Region A	CIC	10.0	8.8	58	377
	OPM-I	11.2	9.7	53	394
	OPM-PI	10.0	8.7	57	394
	OPM-NI	10.0	8.7	57	394
	CIC-BWE	8.0	7.0	50	386
	OPM-NI-BWE	7.6	6.6	46	398
Region B	CIC	2.5	3.6	18	678
	OPM-I	3.1	4.4	14	686
	OPM-PI	2.6	3.7	17	686
	OPM-NI	2.5	3.6	17	686
	CIC-BWE	1.4	2.0	8	686
	OPM-NI-BWE	1.9	2.7	13	689
Region C	CIC	8.7	16.2	85	1,002
	OPM-I	7.9	14.7	66	1,011
	OPM-PI	8.0	14.8	78	1,011
	OPM-NI	8.0	14.8	78	1,011
	CIC-BWE	7.2	13.4	74	1,010
	OPM-NI-BWE	6.8	12.6	71	1,012
Region D	CIC	4.2	4.1	20	337
	OPM-I	3.4	3.3	10	375
	OPM-PI	3.3	3.1	14	365
	OPM-NI	3.3	3.1	14	365
	CIC-BWE	1.7	1.6	7	375
	OPM-NI-BWE	1.5	1.5	6	390
Region E	CIC	1.2	1.9	10	496
	OPM-I	1.1	1.8	2	541
	OPM-PI	0.7	1.1	4	536
	OPM-NI	0.7	1.1	4	536
	CIC-BWE	0.4	0.6	3	542
	OPM-NI-BWE	0.3	0.5	2	556
Total, specified areas	CIC	5.1	35	191	2,890
	OPM-I	5.0	34	147	3,007
	OPM-PI	4.7	31	170	2,991
	OPM-NI	4.6	31	170	2,991
	CIC-BWE	3.6	25	144	3,006
	OPM-NI-BWE	3.5	24	137	3,045

1/ Assumes undiscounted constant dollars and 1974-78 average cotton acreage.
2/ OPM costs do not include costs of diapause and/or overwinter control. Also, farmers' share of eradication costs are not included.

Figure 2. Average Producer Insect Control Costs and Lint Yields by Delphi Management Option, Boll Weevil Infested States (Exclusive of Texas Subregions 30, 32, and 33).

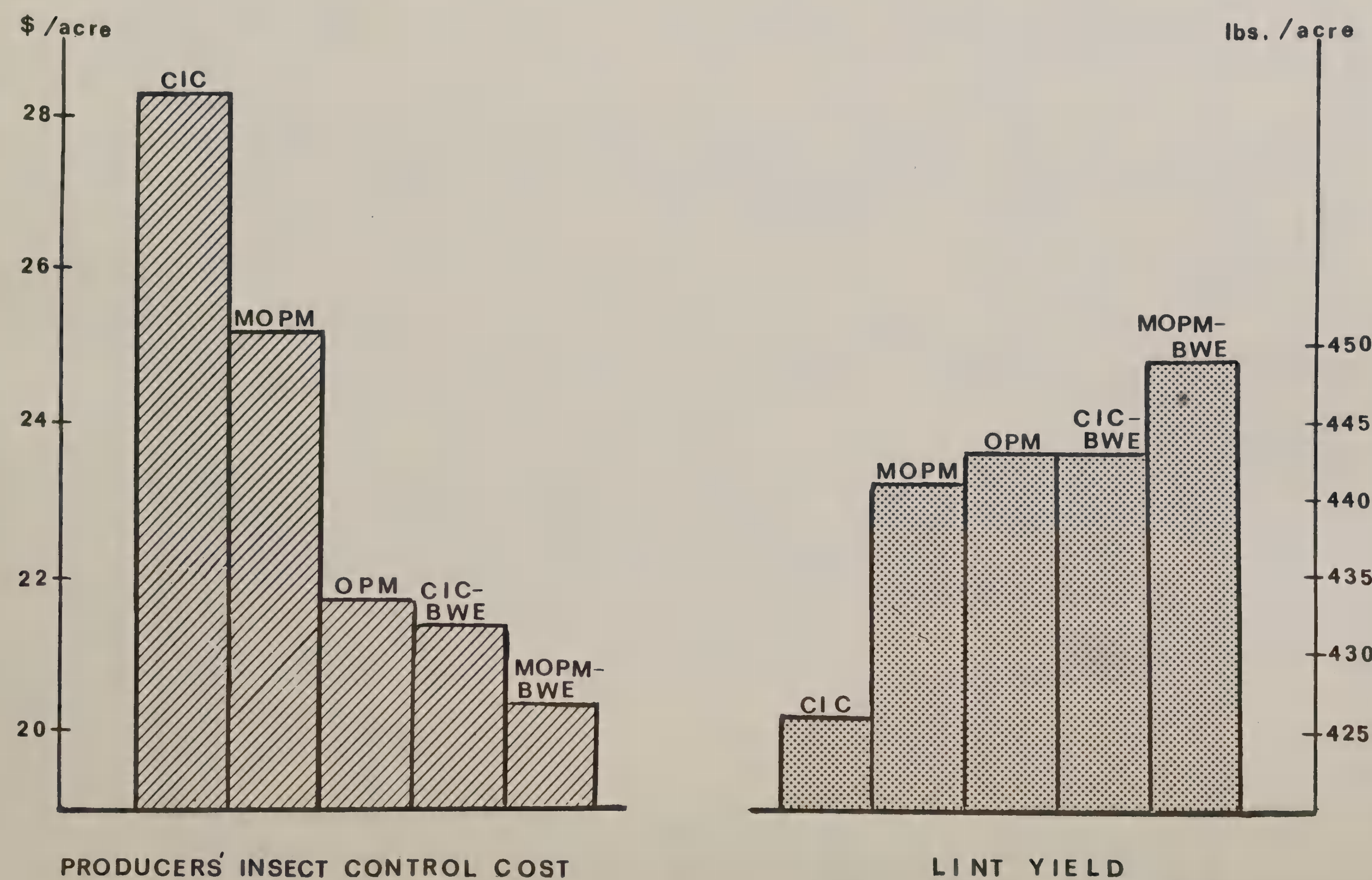
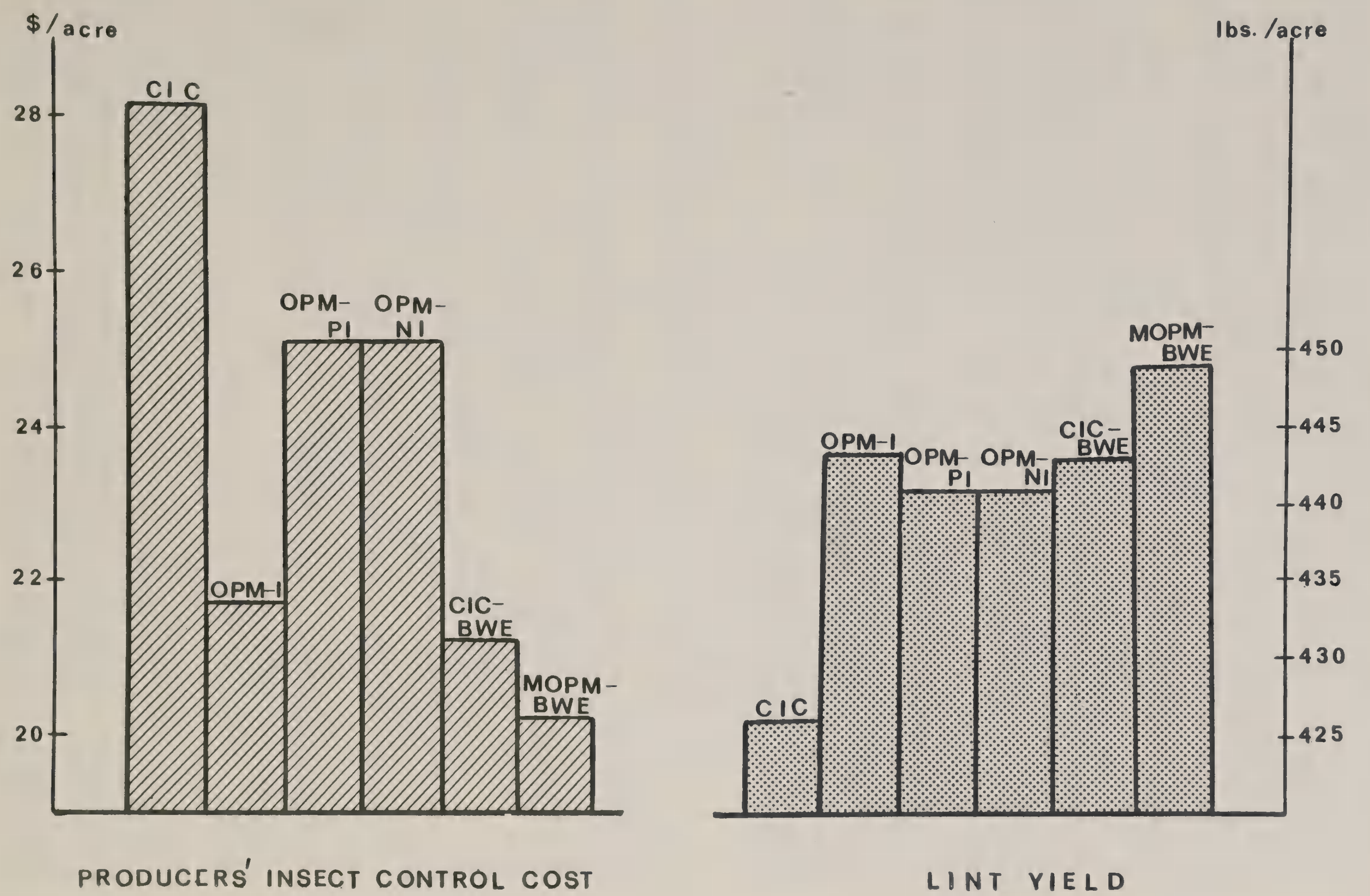


Figure 3. Average Producer Insect Control Costs and Lint Yields by Boll Weevil/Cotton Insect Management Program, Boll Weevil Infested States (Exclusive of Texas Subregions 30, 32, and 33).



EVALUATION OF DELPHI RESULTS

In this section, Delphi results are compared with related published material and information. Historical data bases on cotton insect control practices are available only for comparison with Delphi CIC estimates. Results of similar or related studies are available for use in drawing some general conclusions with regard to the validity of Delphi estimates for the other four management options.

Evaluation of CIC Estimates

USDA periodically has conducted surveys of cotton growers to determine the cost and/or extent of use of pesticides on cotton. Surveys are based on a sample of cotton growers and, until 1979, provided results that could be considered valid only at regional and national levels of aggregation. Cooke and Parvin summarized data obtained from a variety of surveys, specific to the crop years 1969, 1972, 1974, and 1977 (4). Preliminary results of a 1979 USDA survey of pesticide use on cotton also are available but currently are unpublished. Additionally, annual insecticide materials cost data are available through the Firm Enterprise Data System (FEDS) budget generator which develops annual cost of production estimates based on surveys made of samples of growers every three years. These historical year-specific survey data were supplemented in 1978 by collecting from the 11 boll weevil OPM-REEAC members their best subjective estimates of average cotton insecticide usé and costs over a normalized five year period. These data were collected on the basis of Delphi subregions, and are summarized by Cooke and Parvin (4).

Tables 10 and 11 show selected results from the year-specific surveys, discussed above, along with Delphi CIC estimates that have been aggregated to levels appropriate for direct comparison purposes. Although it is difficult to draw inferences from a comparison of year-specific data collected for distinctly different purposes with the normalized (5 year average) Delphi estimates, some general conclusions can be reached through examination of Tables 10 and 11. First, Delphi State-level estimates of the average number of insecticide applications per acre 1974-78 are higher than the average number observed during 1979 for every State except Georgia. Since 1979 is generally known as a crop year for which cotton insect infestations were atypically light, this is not surprising. Second, Delphi CIC estimates of regional per acre numbers of insecticide applications fall within the range of numbers of applications per treated acre observed for the years 1969, 1972, 1974, and 1977. These data sets are not directly comparable since the 1969-77 survey data are expressed in terms of applications per treated acre rather than per harvested cotton acre, which is what the Delphi data show. However, it is clear from Table 10 that the Delphi data express the exact same relative interstate and interregional differences in pesticide use as do the survey data. Next, Delphi CIC estimated average per acre insecticide materials plus application costs are, for every State except Texas, lower than those developed for the period 1977-79 from the FEDS budget generator. However, if one compares the FEDS estimated materials costs for 1979 with the per acre number of insecticide applications estimated from the 1979 cotton pesticide use survey, it is apparent that one of those two data sets is open to suspicion. For example, it is impossible for the estimated 0.1 applications per acre made in Missouri in 1979 to have had materials costs equal to $15.22 per acre. As the FEDS figures are based on a much smaller sample size than the 1979 cotton pesticide use survey sample, they are likely to be less accurate.

Table 12 compares the Delphi CIC insecticide use and cost estimates with those previously collected by Cooke from the 11 OPM-REEAC State Extension pest management specialists. The 11 OPM-REEAC members also participated as Delphi panel members. Both sets of figures are normalized over the same five year period. They generally show very similar results. Only in Arkansas and the Louisiana Red River Valley are data substantially different.

Table 6 includes columns showing actual 1974-78 cotton lint yields per acre and the Delphi CIC estimated lint yields per acre by subregion. Comparison of these columns suggests that, with two or three exceptions, the Delphi panels came within only a few pounds per acre of estimating actual historical yields. The exceptions are in several subregions of East Texas. The rationale for Region D's estimates (in Attachment F) addresses this divergence. The experts on that panel feel there have been some changes in technology that have brought about yield increases that are not reflected in historical yield data.

Evaluation of MOPM and OPM Estimates

Little or no hard data are available for comparison with Delphi MOPM estimates. The contribution of neither Extension nor research input to cotton production with respect to insect control has been empirically examined. The Delphi results, which indicate that MOPM would have a significant, positive impact on yields, are, however, supported by the findings of Griliches and others. Griliches' classic study found that investments in human capital and agricultural research and extension have historically made significant contributions to increases in agricultural output (6). Additionally, the observation that cotton growers are increasingly employing the services of private pest management consultants suggests that they too perceive a net benefit to information provision and technology transfer.

The OPM option was field tested in Mississippi, 1977-80. The results of that trial, although they cannot be assumed to represent beltwide impacts of OPM, provide a useful point of comparison. The trial was conducted in Panola County, Mississippi. Pontotoc County was used as a CIC experimental control area. The base year was 1977 and the trial began in 1978. The Biological Evaluation Report indicates the following base year comparison between counties: (a) the average per acre insecticide applications for thrips, lygus bugs, bollworms and budworms, were 5.65 in Panola and 1.9 in Pontotoc Counties--the trial area, in the year before the trial, made approximately three times as many treatments as the CIC area; (b) in 1977 neither area made applications for boll weevil control; (c) estimated cotton lint yields based on BET sample fields in 1977 indicate Pontotoc County (CIC) yields were 21 percent lower than the pre-OPM sample fields in Panola County. Data for the counties as a whole showed 1977 Pontotoc County average yield was 12.5 percent lower than Panola County average yield.

Examination of the number of insecticide applications observed for the OPM Trial and CIC areas, 1978-1980 (Table 14) suggests that OPM as practiced in the trial area reduced in-season use of insecticides but increased the total annual average number of applications made to cotton acreage. In 1978 and 1979, no in-season boll weevil treatments were made in either county. These were fairly light insect infestation years. This is reflected by the difference, in the CIC area, between the number of applications made in 1977 versus those made in 1978 and 1979. The observation that in 1978-79 CIC area insecticide

use as a proportion of OPM Trial area insecticide use was half that observed during the pre-trial year suggests that diapause treatments were not completely offset by the opportunity to decrease in-season applications in Panola County. In 1980, the proportion of OPM number of applications shown for the CIC area is roughly the same as it was in the pre-trial year, suggesting that in 1980 when weevils posed a problem, diapause treatments were offset by a reduction in in-season treatment in the OPM trial area. The observations support the generalized Delphi OPM estimates. They are not, however, reflected in the Delphi estimates for Mississippi.

The comparative yield data collected is the OPM trial area (Table 14) shed little light on the effect of OPM on cotton lint yield. In both counties, average yield is highly variable over the four years observed. The comparative disadavantage of the CIC area relative to the OPM trial area seems actually to have been decreased during 1978-79. This could have been due to a range of factors unrelated to cotton insect problems. Insufficient data are available to analyze the yield impact of OPM or to directly compare trial results with Delphi estimates.

Using a simulation model, the input to and results of which were tempered with expert (non-Delphi) opinion, Simpson and Parvin estimated the effects of OPM, and of each of the other Delphi options, on cotton insecticide use and lint yield in Mississippi (11). Their study suggests that fully effective OPM would result in a 2.2 to 2.4 decrease in the number of insecticide applications to non-Delta Mississippi cotton. The simulated reduction for the Delta is 0.6 of an application per acre. The Delphi results indicate an average reduction of from one-half application per acre in the Delta to 1.7 applications per acre in South Mississippi. The Delphi estimated OPM yield increases of 2, 5, 6, and 5 pounds lint per acre for the Delta, North Central, South, and Northeast Mississippi, respectively. The corresponding estimates by Simpson and Parvin are 6, 22, 22, and 18 pounds per acre. As both the simulation and the Delphi results are the product of subjective judgement by experts, it is difficult to compare the two in terms of their relative correctness. Only preliminary simulation results were available for consideration by the Delphi panels.

Evaluation of CIC-BWE and MOPM-BWE Estimates

The difference between Delphi estimated CIC, and CIC-BWE average cotton lint yields provides an estimate of yield increases attributable to eradication of the boll weevil. Since the only difference between the CIC and CIC-BWE options is that under the latter there are no weevils, the differences between the estimated yields for these two options also provides a measure of estimated yield losses to the boll weevil. Table 13 shows Delphi estimated losses to boll weevil along with the results of three previous boll weevil yield loss estimation surveys. The earlier two of those surveys were conducted by the National Cotton Council and represent the subjective judgements of one expert per cotton producing State. The size and distribution of the group of experts providing subjective judgements for the USDA/SEA-AR loss estimating process were not specified in the report of its results (13). Comparison across the year or period-specific percentage yield loss estimates shows that most of the Delphi estimates for the period 1974-78 fall within the range of values estimated for the periods 1970-72, 1974-76, and 1979. The exceptions are Delphi estimates for South Carolina, Alabama, Mississippi, and Louisiana, which are lower than the estimates for the other time periods, and Texas, for which the Delphi

estimate is slightly higher than the largest average yield loss estimated through the surveys. Some caution is urged with respect to comparing the Delphi data with the survey data. Ridgway has aptly pointed out in his discussion of the same three published sets of loss estimates that: "some of the limitations of these surveys become evident when several estimates are compared. For instance, when one considers data on losses of cotton due to insects collected over a period of years, it becomes apparent that there are questions about the reasons for the changes over time...Development of and use of improved methodology for assessing losses will likely be required to obtain estimates with high levels of credibility." (9).

Boll weevil eradication was field tested in North Carolina during 1977-80. That trial does not precisely represent either of the two Delphi eradication options. It was more like OPM-NI-BWE than CIC-BWE. An addition to Extension input (one Extension pest management specialist) accompanied the eradication effort, but this did not exactly parallel the OPM-NI-BWE option evaluated by the Delphi. The presence of eradication personnel and other attention given to the area of the trial also prevent it from having been a representation of CIC-BWE. Nevertheless, results of the trial's evaluation provide some information that is useful for comparison with Delphi estimations. Carlson and Suguiyama (3) determined the historical difference in pest control and other factors between the BWE Trial and CIC areas, compared the two Trial zones based on those differences, and also examined differences in the eradication zone before and during eradication. These authors drew concluded: 1) there was a larger reduction in private cotton insect control cost in the eradication zone than in their study's control zone; it was not possible to detect any yield changes from the eradication; and 2) "In the North Carolina eradication zone the presence of eradication personnel and the absence of the need to treat for weevils has reduced insecticide use relative to prior periods and a comparison area" (3). The Delphi estimated reductions in insecticide use and insect control cost for subregions 1 and 2 (which approximates the trial eradication zone) are similar to those resulting from analyses by Carlson and Suguiyama. Yield change comparisons cannot be made because there was insufficient data to estimate the eradication trial's effect on cotton lint yield in North Carolina.

Table 10. Survey estimates of insecticide applications on cotton acreage 1969, 1972, 1974, 1977, and 1979, compared with Delphi CIC by State and/or region

State and Delphi region	Average number of applications per treated acre					
	1969 1/	1972 1/	1974 1/	1977 1/	1979 2/	1974-78 3/
North Carolina					NA	8.4
South Carolina					7.0	10.0
Georgia					15.2	12.5
Alabama					5.2	9.0
Region A	7.2	13.5	14.0	15.9	NA	10.0
Tennessee					0.3	3.0
Missouri					0.1	0.9
Arkansas					1.6	2.7
Region B	3.6	4.6	6.3	1.8	NA	2.5
Mississippi					5.7	8.6
Louisiana					7.5	9.0
Region C	4.5	6.8	7.2	8.9	NA	8.7
Texas					1.0	1.6
Oklahoma					0.9	1.1
Region [illegible]	2.8	4.2	5.6	5.4	NA	4.2
Reg[illegible]	2.6	2.4	3.1	0.4	NA	1.2

1/ USDA, ESS survey data. The estimates are year-specific. Survey data are reliable only at the regional level. See Cooke and Parvin for Details (4).
2/ Survey estimated number of acre-treatments for State, divided by 1979 cotton acres harvested for State (from (12)). USDA, ESS 1979 cotton pesticide use survey preliminary results are specific to 1979 and data possess State level significance (14).
3/ State estimates calculated by taking weighted, by acreage, average of subregional estimates.

Table 11. Comparison of FEDS estimated average per acre costs of insecticide materials, 1977, 1978, and 1979, with Delphi CIC estimated average per acre insecticide materials plus application costs, 1974-78, by State

State	Average materials cost per acre 1/			Delphi CIC estimated average materials plus application costs per acre 1974-78 2/
	1977	1978	1979	
	1979 constant dollars			
North Carolina	81.88	71.19	63.70	51.20
South Carolina	88.45	76.90	68.81	65.18
Georgia	84.66	73.61	65.86	84.07
Alabama	82.82	72.00	64.42	59.22
Tennessee	40.53	35.24	31.53	12.64
Missouri	19.56	17.01	15.22	3.11
Arkansas	27.79	24.16	21.61	14.18
Mississippi	57.29	49.82	44.57	43.39
Louisiana	65.12	56.61	50.65	52.57
Texas	5.17	4.35	3.80	8.60
Oklahoma	7.05	8.39	7.37	6.38

1/ See Cooke and Parvin for details (4).

2/ State estimates calculated by taking weighted, by acreage, average of subregional estimates.

Table 12. Comparison of OPM-REEAC normalized estimates of average per acre insecticide use and costs, with Delphi CIC estimates, by Delphi subregion and region

Delphi subregion and region 1/	Estimated average number of insecticide applications per acre		Estimated average cost of insecticide use per acre	
	1978-CIC 2/	Delphi CIC	1978-CIC, material costs only 2/	Delphi CIC materials costs only
			dollars per acre	
4,6, & 7- SC, NC, and GA Piedmonts	7.2	6.5	$38.32	$29.07
5 - SC, Coastal Plain	12.6	10.4	64.16	52.46
8 - GA, East	13.0	12.7	70.34	63.42
9 - GA, Southwest	13.6	13.7	71.10	67.70
10 - Alabama, North	6.6	6.7	34.63	34.52
11 - Alabama, South	11.5	12.3	54.13	62.73
REGION A	12.5	10.0	64.02	51.20
12 & 13 - Tennessee	2.1	3.0	14.71	7.39
14 - Missouri	1.3	0.9	3.49	1.31
19 - Arkansas, Northeast	2.2	1.0	6.37	1.92
20 - Arkansas, Southeast	6.2	4.4	26.54	19.09
REGION B	3.7	2.5	13.51	8.11
15 - Mississippi, Northeast	7.9	7.5	24.42	25.47
16 - Mississippi, North Central	9.7	8.4	31.39	29.08
17 - Mississippi, Delta	9.5	8.7	47.35	33.95
21 - Louisiana, Northeast	9.6	9.0	40.01	34.90
22 - Louisiana, Red River Valley	14.0	9.0	82.95	38.72
REGION C	9.0	8.7	40.94	33.17

Table 12. - continued

Delphi subregion and region 1/	Estimated average number of insecticide applications per acre: 1978-CIC 2/	Estimated average number of insecticide applications per acre: Delphi CIC	Estimated average cost of insecticide use per acre: 1978-CIC, material costs only 2/	Estimated average cost of insecticide use per acre: Delphi CIC materials costs only
			dollars per acre	
23 & 40 - TX Lower Rio Grande	5.3	6.5	20.17	24.28
24 - Texas, Lower Bend	4.0	3.3	10.56	9.24
25 - Texas, Upper Bend	7.6	5.7	26.46	13.70
28 - Texas Blacklands	2.2	2.4	2.40	3.38
REGION D	3.8	4.2	10.98	12.56
29 - Texas Rolling Plains	1.0	0.9	1.46	1.82
32 & 33 - Pecos and El Paso Valleys	2.3	0.8	9.89	4.68
REGION E 3/	1.0	1.2	5.81	3.71

1/ Excludes subregions 1, 2, 3, 18, 26, 27, and 31 since 1978-CIC estimates for these subregions were not reported in source (4). Excludes subregions 30, 34, and 35 because Delphi estimates for those subregions are restricted to dryland acreage.

2/ Result of survey conducted by Fred Cooke in 1978 of OPM-REEAC committee members. Data represent the subjective judgements of those eleven (one per State) Extension entomologists. Estimates are normalized for the period 1974-78 (4).

3/ Estimates shown are for boll weevil infested portions of Region E only.

Table 13. Comparison of Delphi estimated boll weevil yield losses with published estimates of losses to boll weevil

State	Estimated percent yield loss to boll weevils			
	National Cotton Council estimates for 1970-72 1/	Cotton Foundation estimates for 1974-76 2/	USDA/SEA-AR estimates for 1979 3/	Delphi estimates for 1974-78 4/
North Carolina	18	6.4	0.05	2.9
South Carolina	11	4.4	3.0	2.4
Georgia	23	2.4	16.0	4.4
Alabama	18	2.4	12.8	1.5
Tennessee	4	2.4	0	0.7
Missouri	3	0.3	0	1.1
Arkansas	3	1.5	0.5	0.85
Mississippi	9	3.4	3.2	0.5
Louisiana	9	6.7	4.0	1.6
Texas	4	2.35	1.6	4.9
Oklahoma	9	7.1	0	4.2
11 State average	7.4	2.9	NA	3.8
U.S. average	NA	NA	1.4	NA

1/ Information developed from a survey conducted by the National Cotton Council in cooperation with State Extension specialists. The estimates were based on "the knowledge available to the specialists" (1).

2/ Information developed from a survey mailed from the National Cotton Council to the Cooperative Extension Service in 14 major cotton States. The estimates were based on "the knowledge available to the insect and weed specialists in each State" (5).

3/ Insect loss data developed "under auspices of the (33rd Annual Cotton-Insect Research and Control) conference". Data are specific to crop year 1979. Sources, methodology and other details of the estimation process are unavailable from the published report (13).

4/ Calculated from Delphi data by determining the percentage difference between estimated CIC-BWE yields and CIC yields. State estimates were developed by taking a weighted average, based on cotton acreage, of the subregional percent yield losses calculated.

Table 14. Insecticide use and cotton lint yield in Mississippi OPM Trial and CIC areas, 1977-80 1/

Year	Average, annual number of insecticide applications per acre			Average cotton lint yield per acre based on sample field data			Average cotton lint yield per acre for entire county		
	Panola Co. (OPM trial area) 2/	Pontotoc Co. (CIC control area)	Pontotoc Co. estimate as proportion of Panola Co. estimate	Panola Co. (OPM trial area)	Pontotoc Co. (CIC control area)	Pontotoc Co. estimate as proportion of Panola Co. estimate	Panola Co. (OPM trial area)	Pontotoc Co. (CIC control area)	Pontotoc Co. estimate as proportion of Panola Co. estimate
			-- percent ---	-------- lbs./acre	-------	---percent---	------- bales/acre	-------	--percent ----
1977 (pre-trial)	5.65	1.9	34	776	615	79	1.6	1.4	87.5
1978	6.6	0.96	15	625	538	86	1.3	1.1	85
1979	6.8	0.7	10	559	574	103	1.2	1.1	92
1980	7.1	2.21	31	586	430	73	1.2	0.9	75

1/ From Biological Evaluation Report (Nov. 11, 1980 Draft)

2/ Includes four diapause treatments per year in 1978-80.

CRITIQUE OF THE DELPHI

In February 1981, Delphi participants were asked to provide an anonymous critique of the Delphi process and its results. The overall objective of the critique was to identify areas for improvement of the modified Delphi so that future efforts of a similar nature could capitalize on the successful aspects and avoid problems experienced with the Delphi. Additionally, the critique provides an assessment of participants' judgements of the validity of the Delphi results.

A Delphi Critique Form (Attachment I) was mailed to each of the panel members, resource people, facilitators, and administrators. Their response rate was 77 percent. The response pattern to each item is shown in Attachment I. Selected results are discussed below.

The first 11 questions were solely directed towards the Delphi expert panel members. Overall, the panel members seemed satisfied with most aspects of the Delphi process. Average responses indicate they agreed, to varying extents, that: the resource presentations were helpful; they were able to obtain the background information needed to respond to the questionnaire; summary statistics were easy to interpret and were not overwhelming; and the process allowed them the freedom to disagree with others while providing anonimity of response. Although over half of the responding panel members agreed to some extent that the questions on the Delphi questionnaire were precise and unambiguous, the average response to that statement indicates some dissatisfaction with the precision of the survey instrument. This also is reflected in the fact that 75 percent of the responding panel members indicated they experienced some degree of difficulty in using the questionnaire to describe the average insecticide use patterns they believed would result under alternative boll weevil/cotton insect management options. There was strong agreement among panel members that the group facilitators neither tried to influence the outcome of the exercise nor allowed domination of the groups by any one or a few individual panel members. Only two of the responding panel members expressed unwillingness to serve as expert panelists in another similar Delphi exercise. In addition to indicating the degree of agreement or disagreement with each statement on the Delphi Critique Form, many panel members provided specific comments with respect to items 1-11. These comments should be particularly helpful in future efforts to design modified Delphi data collection methods. The specific comments have been compiled, and a copy of the compilation has been sent to each Delphi participant.

All Delphi participants, including the panel members, were asked to respond to items 12-22 on the Delphi Critique Form. These items dealt with the overall organization of the Delphi process and validity of its results. Over 80 percent of the 50 respondents agreed to some extent that the Delphi panels were comprised of individuals who possess a high degree of expertise. Over 90 percent further agreed that the panels included individuals with a range of perspectives and experiences. There is greater variance in response to the statmeent that the panels were not biased with respect to overrepresentation by any one subgroup. While 45 percent of the respondents agreed or strongly agreed and 20 percent agreed somewhat that the panels were not biased, 28 percent disagreed to some extent with that statement. About three-quarters of the responding participants agreed that the Delphi process was well

organized and there was strong agreement by the entire group that the face-to-face component of the process led to better estimates than could have been collected through a mail survey or other individual based methods. Regarding the estimates, average responses indicate general agreement that the Delphi results are "realistic representations of the average situations expected for an average year under the conditions described by program definitions", and slightly higher overall agreement that the results "provided the best possible beltwide estimates...given: current state of knowledge and time constraints." Less than one-fourth of the respondents felt that the review and revision process was prematurely ended. Finally, there was strong general agreement that the meetings increased "understanding and communication among cotton experts", and strong disagreement by participants that their time was ill-spent in involvement with the Delphi. Respondents' comments regarding items 12-22 were recorded, compiled along with all other specific and general comments, and provided to each Delphi participant.

One of the frequently cited advantages of the conventional Delphi approach is its relative low cost. The modified Delphi followed here was not inexpensive with respect to the time and effort expenditures by its participants. Item E on the Delphi Critique Form asked for an estimate of the time spent by each participant in preparing for and implementing his or her role in the Delphi. Based on their responses to that item, the equivalent of approximately 4-5 person-years were devoted to the Delphi process and the generation of its results.

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ATTACHMENT A

ORGANIZATION OF DELPHI

ORGANIZATION OF DELPHI

ADMINISTRATIVE PERSONNEL

1. Velmar Davis, ESS, Wash., DC
2. Irv Starbird, ESS, Wash., DC
3. Beverly Herath, ESS, Wash., DC
4. Ken Keller, Overall Coordinator, NC
5. Cleveland Marsh, ESS, Wash., DC
6. Pete Liapis, ESS, Wash., DC
7. Rick Farnsworth, ESS, Wash., DC
8. Peter Rich, ESS, Wash., DC
9. Melanie McDowell, ESS, Wash., DC
10. Dick Ridgway, SEA-AR, Wash., DC
11. Joe Blackwell, DSC, Wash., DC
12. Gene Simpson, AES, MS
13. Luis Suguiyama, AES, NC

OBSERVERS

1. Jim Touhey, EPA, Wash., DC
2. Ted Moriak, OBP&E, Wash., DC

QUESTIONNAIRE REVIEW AND PRETEST COMMITTEE

Velmar Davis -- OET
Ed Lloyd -- BET
Fred Cooke -- EET
Gerald Carlson -- EET
Katherine Reichelderfer -- ESS
Jim Smith -- BET
Herman Delvo - ESS

DELPHI PANEL

1. Eleven members of OPM REEAC
2. Research/Extension entomologists and agronomists
3. Five farmers recommended by Ritchie Smith
4. Three pest control consultants recommended by Earle Raun
5. Three State Dept. of Agr. Reprs. recommended by Al Elder
6. Four representatives of chemical industry recommended by Jack Early

ASSIGNMENTS FOR DELPHI -- OCTOBER 23-25

REGION A -- Virginia, North Carolina, South Carolina, Georgia, and Alabama (Sub-regions 1-11)

Panel Members	Resource Staff
1. Jack Bacheler, CES, NC	1. Kitty Reichelderfer (F), ESS, Wash., DC
2. Donald Johnson, CES, SC	2. Ed Lloyd, SEA-AR, NC
3. W. R. Lambert, CES, GA	3. Marshall Grant, Producer, NC
4. J. B. Weaver, CES, GA	4. Milton Ganyard, APHIS, NC
5. J. R. Bradley, AES, NC	
6. Herbert Henry, PCC, GA	
*7. Charles Lichy, CI, NC	
8. Ron Smith, CES, ALA	

REGION B -- Tennessee, Missouri, and Arkansas (Sub-regions 12-14, 19 and 20)

*1. Flernoy Jones, CES, MO	1. Herman Delvo (F), ESS, Wash., DC
2. Gordon Barnes, CES, ARK	2. Jake Phillips, AES, ARK
3. Dwight Lincoln, Producer, AR	3. Gerald McKibben, SEA-AR, NC
4. Jimmy Pendergrass, CES, TN	4. Bill Cross, SEA-AR, MS
5. Ed Kowalski, CES, MO	
6. Don Hays, CI, MS	
*7. Don Allemann, CI, NC	

REGION C -- Mississippi, and Louisiana (Sub-regions 15-18, 21, and 22)

1. Robert Head, CES, MS	1. Jerry Carlson (F), AES, NC
2. Jim Hamer, CES, MS	2. Gordon Andrews, CES, MS
3. Mike Williams, CES, MS	3. Jim Smith, SEA-AR, MS
4. Dan Clower, AES, LA	*4. Larry Brown, AES, MS
5. John Barr, Producer, LA	5. David Young, CES, MS
6. John Kimbrough, PCC, MS	*6. Monty Randolph, Producer, MS
7. Jim Conner, CI, Wash., DC	
8. Jim Tynes, CES, LA	
9. Harry Fulton, SDA, MS	

Organizational abbreviations follow:

F -- Facilitator
CES -- Cooperative Extension Service
AES -- Agricultural Experiment Station
SDA -- State Department of Agriculture
PCC -- Pest Control Consultant
CI -- Chemical Industry
ESS -- Economics and Statistics Service
BET -- Biological Evaluation Team
EET -- Economic Evaluation Team
OET -- Overall Evaluation Team

* Not available for October 23-25 Delphi.

REGION D -- East Texas (Sub-regions 23-28)

Panel Members	Resource Staff
*1. Ray Frisbie, CES, TX	1. John Schaub (F), ESS, Wash., DC
2. Roy Parker, CES, TX	*2. George Slater, AES, TX
3. J. K. Walker, AES, TX	3. Fred Cooke, ESS, MS
4. Dan Pustejovsky, Producer, TX	4. Jim Brazzel, APHIS, TX
5. Stan Nemec, PCC, TX	5. Neil Namken, SEA-AR, TX
6. Tom Helms, CI, MO	
7. Tommy Funk, Producer, TX	

REGION E -- West Texas (Sub-regions 29-35)

1. G. M. McWhorter, CES, TX	1. Dave Parvin (F), AES, MS
2. Eldon Cleveland, CES, OK	2. Juan Lopez, SEA-AR, TX
*3. J. H. Young, AES, OK	*3. Charlie Parencia, SEA-AR, MS
*4. D. R. Rummel, AES, TX	

ATTACHMENT B

DELPHI QUESTIONNAIRE

— SAMPLE QUESTIONNAIRE —

I. Current Control Practices

(II. OPM / III. BWE) same form)

Name:
Region:
Subregion:

125,000

Q1 Target Insect Complexes	Q2 Acreage, OR % Acreage Each Complex	Q3a Most Frequently Used Materials	% use	Q3b Dosage, if other than rec. rate (a.i./acre)	Q4 Number of Insecticide Applications with Infestation: Zero	Light	Moderate	Heavy	Q5 Probabilities of Infestation: Zero	Light	Moderate	Heavy	For Use By Computation Expert: Avg Cost	Avg No.
Plant bugs	10,000 acres (8%)	Cygon	.50		0	2	2	3						
		Bidrin	.50	.15	0	1	2	3	.50	.30	.20	0		
Weevil	20,000 acres (16%)	Guthion	.40		2	3	4	5						
		3+3	.20		3	4	5	6	.30	.20	.20	.30		
		6+3	.40		1	3	4	5						
Weevil-Worms	65,000 acres (52%)	Guthion + pyrethroid	.20		0	2	3	5						
		Pyrethroid	.20		0	2	3	5						
		3+3	.20		1	3	4	6	.10	.40	.40	.10		
		3+3 + Ovicide	.20		0	2	3	5						
		*Pyrethroid, 3+3	.20		0,1	1,2	2,3	2,5						
Bollworm - Budworm	60,000 acres (48%)	Pyrethroid	.25		0	2	2	2						
		Azodrin	.75		1	1	2	2	.70	.20	.10	0		
No Insect Problem	0													

* sequential combination

I. Current Control Practices (continued)

Target Insect Complex	Q6: 425 Absolute or Indexed Cotton Lint Yields with Treatment, and Target's Infestation Level (all other pest problems constant at average level)				Q7 Special Problems that May Change Cotton Production Costs or Yields for this Complex
	Zero	Light	Moderate	Heavy	
Plant bugs	425	425	425	420	
Weevil	430	425	425	415	
Weevil - worms	425	425	420	410	
Bollworm - Budworm	425	425	425	425	
No Insect Problem	430				

Expert Enumerator Directions

I. Current Practices in Cotton Insect Control (CIC)

Assume current practices over the past 5 years with currently known and used technology. Remember to describe what you think the average farmers are doing, not what you hope they are doing or think they will be doing in the future. Assume beneficial insects are at average levels.

Q1: Give the major cotton insect pests or pest complexes which farmers face in this area (See map for areas).

(a) Pest complex categories are exhaustive of all pest situations treated at least once per season. Ignore pests never treated for.

(b) Examples of a set of complexes might be: plant bugs, weevil only, weevil-worm, worm and miscellaneous insects.

Q2: What cotton acreage (acres, or percent of total area) in the past 5-10 years falls in each of the pest complex categories? This gives an acreage scaling of the importance of each pest complex.

Q3a: For each pest complex list:

(a) Most frequently used materials (common names).

(b) Percentage of farmers (acreage) using each pesticide for this complex. Percentages must add to 100.

Q3b: Average dosages (active ingredients/acre) used, if other than recommended rates.

See the sample questionnaire. For Q3a the complex weevil only has three insecticides listed as most frequently used (guthion, 3 + 3, and 6 + 3). The percentages of farmers (acreage) using each are 40, 20, and 40. No entries are given in Q3b because the average dosages used were the state recommendations in this example.

Q4: It is necessary for us to estimate the applications per season for each insecticide treatment program in each complex. This will vary by level of insect infestation. Infestation level is defined in terms of the duration of the cotton season the insect complex is present, the percent of one's acreage infested, the level of the pest population, and the susceptibility of the cotton fruit.

Give your estimates of the numbers of insecticide applications per season for this complex for each of the four infestation levels. Use the worksheet to arrive at average numbers. (Insert zeros if zero is your estimate.) Please remember that you are estimating what farmers <u>do</u>, not what you recommend. It is widely documented that, in some cases, zero infestation level cotton receives insecticide application.

In the sample questionnaire, Q4 is estimated to be 2, 3, 4, and 5, for the use of guthion on weevils for zero, light, moderate, and heavy infestations, respectively.

Q5: Considering the acreage treated for each complex (see your Q2 entries), what is the probability of zero, light, moderate, and heavy infestations occuring? For example, it may be easiest to think of this as, "How many years in 20 would the average acre have a light infestation?" Frequencies are considered probabilities. Probabilities must add to 1.0 for the four infestation levels.

In the sample questionnaire these figures are 0.3, 0.2, 0.2, and 0.3 for the <u>weevil only</u> complex.

For pest complexes with 2 or more species, consider the <u>sum</u> of the pests, in your definition of zero, light, moderate and heavy, and their related probabilities.

Q6: With the four infestation levels there are various levels of insecticide treatments and insect crop damage. Give your estimates of cotton lint yields for the area exposed to the pest complex for each of the infestation levels and treatment regimes that farmers use for each. Average over materials listed in Q3.

Check: The subregional average yield ($\bar{Y}$) is given on page 1. This should be equal to your weighted average yield, where the weights are the probabilities in Q5.

In our example, for a moderate infestation which we say usually gets 4 treatments, the yield is 425. The yield with heavy infestation and 5 insecticide applications is 415, and the yields with low and zero infestations are 425 and 430, respectively.

Q7: Give special problems for each insect complex that might cause yield or production cost changes.

II. Repeat Q2, Q3, Q4, Q5 and Q6 for each pest complex.

III. Repeat for each subregion

IV. Repeat all of Q1-Q7 for OPM, for each subregion

1. assume eradication is successful

2. assume no acreage changes in cotton at the state level as a result of eradication

V. Repeat all of Q1-Q7 for Eradication, for each subregion

1. assume OPM is fully implemented (need not represent a change from current practices on all acreages)

2. assume no acreage changes

VI. Answer questions Q8 through Q11.

ATTACHMENT C

BOLL WEEVIL PROGRAMS AND OPTIONS

BOLL WEEVIL PROGRAMS AND OPTIONS 1/
by
Velmar W. Davis 2/

My assignment this morning is to set the stage for the next 2 days and possibly 2 1/2 days of Delphi activities. Some of you are more familiar than others with the definitions and evaluations of alternative programs. Thus we will begin this second Delphi meeting with: (1) a brief review of the overall objectives of the evaluations; (2) an identification of the major beltwide boll weevil/cotton insect management programs; and (3) a description of the program options that you will be considering in your Delphi panels, with emphasis on changes since the April meeting.

Overall Objective 3/

Very simply, the overall objective of the evaluations, of which the Delphi is a major component, is to develop information to facilitate the choice of a beltwide cotton insect management program. This information will be made available to the Secretary of Agriculture, OMB, Congress, producers, and the public for their use in choosing a program. I want to emphasize in that the focus of the evaluations and the Delphi activities is on the management of boll weevil as a component of a cotton insect management program.

Identification of Beltwide Programs 4/

We plan to evaluate six cotton insect management programs for the boll weevil infested areas of the cotton belt. The following titles of the six programs are the same as those that were described to you during the April Delphi meeting:

(1) Current Insect Control (CIC);

(2) Optimum Pest Management with Continuing Incentive Payments for Boll Weevil Management (OPM-I);

1/ Presented at the Second Cotton Insect Boll Weevil Management Delphi Meeting, Memphis, TN, October 23-25, 1980.

2/ Overall Evaluation Leader, ESS, USDA, Washington, D.C.

3/ Additional information on the evaluations can be found in "Overall Evaluation Plan for Alternative Beltwide Cotton Insect Management Programs".

4/ A more detailed description of the six programs to be evaluated is contained in the materials distributed to the Delphi participants.

(3) Optimum Pest Management with Phased Incentive Payments for Boll Weevil Management (OPM-PI);

(4) Optimum Pest Management with No Incentive Payments for Boll Weevil Management (OPM-NI);

(5) Optimum Pest Management with Boll Weevil Eradication (OPM-BWE); and

(6) Current Insect Control with Boll Weevil Eradication (CIC-BWE).

A common requirement of all OPM programs is that additional Extension personnel and support would be required to provide technical assistance and educational guidance in the management of the boll weevil as well as other cotton insects.

Program Options to be Delphied

As we shift our thinking from beltwide programs to options to be Delphied, we must try to visualize these options 4 to 5 years after they have been introduced and their effects have stabilized. In describing the options to be Delphied, I will emphasize changes that have occurred in definitions since the April Delphi meeting. Descriptions of the five options follow:

(1) Current Insect Control (CIC). There have been no changes in the definition of CIC as you Delphied it in April and in subsequent rounds. CIC assumes insect control as now practiced by producers that ranges from no control to intensive treatment with insecticides. CIC implies a continuation of Extension education and technical assistance at the present level of funding.

(2) Optimum Pest Management (OPM). Likewise, the definition of an effective OPM option has not changed. However, the context in which we now view effective OPM has changed. It is one of two options available in implementing beltwide OPM programs. The beltwide programs consist of two major insect management options, OPM and Modified OPM, whichever is most applicable for a particular area. In implementing both options, additional Extension personnel and support would be required to provide technical assistance and educational guidance in the management of the boll weevil and other cotton insects.

First, let me describe an effective OPM option. It would utilize the boll weevil/cotton insect management practices that were tested in the Mississippi Trial with emphasis on diapause and/or pinhead square treatments, as needed. In areas having potential for moderate to heavy infestations of the boll weevil, diapause and/or pinhead square treatments would be implemented. The criterion for an effective area-wide OPM option is to maintain mid-season populations of boll weevils below treatment levels on 90 percent or more of the acreage prior to on-set of Heliothis pressure.

As part of your Delphi activities, you will be asked to estimate the percentage of the cotton acreage in each subregion that would be covered by an effective OPM option with full incentives, phased incentives and with no incentives. The different levels of incentives merely represent suboptions of effective OPM. In the first suboption, (OPM-I), producers would receive full reimbursement for all diapause/pinhead square treatments, as needed. In the second suboption (OPM-PI), reimbursements would be phased 100 percent, 75 percent, and 50 percent and none, respectively, for years one through four.

(3) Modified Optimum Pest Management (MOPM). The third option that you are asked to Delphi is applicable in areas where the required levels of producer participation cannot be reached with the OPM suboptions (incentives, phase incentives and no incentives) or where boll weevil infestations are historically light and usually do not reach treatment levels. In other words, once you have decided upon the acreage to be covered by an effective OPM option, the remaining acreage, either part of a region or a full region, would be covered by the MOPM option. This option implies that diapause/pinhead square technology either could not be adopted on a sufficient percentage of the cotton acreage for an effective area-wide OPM option or it would not be needed because of low population levels of boll weevil. The objective of MOPM is to reduce the number of unnecessary inseason treatments for boll weevil and other cotton insects through effective scouting and/or monitoring. Diapause and/or pin-head technology may be present as a management practice of individual farmers. In-season treatments for boll weevils may occur. Examples of areas where diapause or pinhead squares treatments are not commonly needed may include north Alabama, Mississippi Delta, northwest Tennessee, Missouri Bootheel and northeast Arkansas.

(4) Modified Optimum Pest Management without Boll Weevil (MOPM-w/o BW). If I recall correctly, four of the five Delphi panels considered an OPM-without-boll-weevil option in their April and subsequent rounds of the Delphi. Since we assume that the boll weevil has been eradicated, the MOPM option is a more correct description of insect management practices following eradication than the OPM option. In this instance, we changed th[illegible] but did not change the definition of what was Delphied. Und[illegible]tion, add[illegible]onal Extension personnel and support would be requi[illegible]provide te[illegible]nical assistance and guidance to growers on how best to manage cotton [illegible]sects in the absence of the boll weevil.

(5) Current Insect Control without Boll Weevil (CIC-w/o BW). Here again, as in the MOPM-w/o BW, we assume that the boll weevil has been eradicated but we are now viewing the CIC practices without boll weevil. The CIC-w/o BW option assumes no additional staffing or funding of extension programs prior to, during or following eradication. You need to consider the residual effect of having conducted and eradicated the boll weevil-- both positive and negative if any -- including any effects of the absence of boll weevils on the need for treatment of the remaining cotton insect pests.

Technology Assumption

Before I conclude my review, I want to clarify the Delphi assumption concerning technology. A common technology base is assumed for all program options. We have assumed a constant technology base which, for Delphi purposes, consists of insect management technologies that have been tested and are recommended or available for use in 1980. Do not base your estimates of insecticide use or yields on projected future or near-known technologies. However, your estimates should reflect any changes in rates of adoption of base technologies as a result of additional Extension personnel and support in providing technical assistance and guidance in the management of boll weevil and other insects. Any estimates of changes in adoption rates should be restricted to technologies for which efficacy has been thoroughly demonstrated.

This concludes my brief review of the overall objective of the evaluations, the titles of the beltwide programs to be evaluated, the options to be Delphied and the Delphi technology assumption. Now, Dick Ridgway will introduce selected resource staff for presentations of key information that we believe will be of general interest to all panels.

ATTACHMENT D

GUIDELINES FOR FACILITATORS

THIRD ROUND DELPHI
GUIDELINES FOR FACILITATORS

During the third and final round of the cotton insect/boll weevil Delphi process, the facilitators will play an especially critical role. They must be flexible so that the best and most objective estimates possible are obtained by the end of the round, but also must maintain and protect consistency across regional panels. With this in mind, it may be helpful to review the general process (game rules) segment of the facilitators' guidelines developed for the first round. On the attached copy, game rules that do not apply during the third round are crossed out, and those that continue to be of particular importance are starred.

The first step of the third round of the Delphi is the review and finalization of CIC estimates.

A. <u>CIC Review and Finalization</u>

1. Review,, with panel members, the portions of Tables 1 and 4, and/or Tables 13 and 14 that apply to your region, as an overview of the region's second round results. Discuss any general issues at this point.

2. Select a single subregion for more indepth review. (The first time this is done, you may want to focus on a subregion for which 2nd-round Delphi results are consistent with available survey or other published data. In other words, start out on a positive note.)

3. Compare, with panel members, 2nd-round Delphi group average estimates made for the subregion with:

   a) extension estimates collected by Cooke

   b) survey data summarized by Cooke, Parvin, Marsh

   c) any other available <u>published</u> data on insect control costs, insecticide use or cotton yield in that subregion.

   d) actual and simulated data from trial areas, IF subregion is in Mississippi or North Carolina

4. Have each panel member review his computerized individual CIC responses for the subregion, for final concurence.

5. Ask the panel members if, given the comparison just made, they are willing to accept the validity of and use as the final set of CIC figures, the 2nd-round Delphi group average estimates for that subregion. (If time permits, this should be accomplished by an anonymous, written vote.)

   IF THEY AGREE <u>AND</u> THE SUBREGION IS NOT ONE OF THOSE PREVIOUSLY IDENTIFIED AS A PROBLEM SUBREGION, select a new subregion for CIC review and finalization.

IF THEY AGREE BUT THE SUBREGION IS ONE PREVIOUSLY IDENTIFIED AS A PROBLEM BECAUSE OF HIGH STD. DEV. or DISCREPANCY WITH SURVEY OR OTHER DATA, proceed to steps 5-8.

IF THEY DO NOT AGREE, proceed to steps 5-8.

6. Have each panel member look at his computerized response for CIC in the subregion identified. Also have everyone look at that subregion/mgt. option summary sheet. Give them a few minutes to review.

7. Ask if, after in-depth review, anyone is unhappy with his own previous estimates.

   IF YOU GET "YES" ANSWERS, go through each component on questionnaire to identify source of problem or dissatisfaction. Make sure "outliers" are involved in revision or can defend their positions.

   IF YOU GET NO POSITIVE RESPONSE, identify the responses that lie furthest from the mean, and challange the "outliers" to defend their positions.

8. Revise CIC group average response for the subregion.

   Have each individual revise his own responses so that the summary statistic(s) in question will more accurately reflect his revised view. This should be done directly on the computerized individual response sheets, and immediately given to a data file editor.

   ** NOTE: The facilitator must keep a record of all revisions transmitted to the data file editors.

9. Repeat steps 2-8 for all subregions in the region.

   TRY TO FINALIZE CIC BY NOON, OCT 23.

B. OPM Review

1. Review definitions of the OPM components. For consistency's sake, please use the following explanation.

The implementation of OPM will vary from subregion to subregion. One component of OPM that every subregion must consider is the proposed addition of resources to Extension and other forms of grower education. In subregions where the boll weevil IS NOT a pest of great importance, increased Extension and education comprises the only difference between CIC and OPM. On the other hand, in subregions where boll weevils PRESENT A PROBLEM, a second component of OPM would be a diapause control and/or pin head square treatment program.

"Effective OPM" means that no mid-season treatments for boll weevils are required prior to Heliothis treatments on at least 90 percent of an area's cotton acreage. Meeting this performance criterion may be a function of increased Extension and education, of diapause control, or of a combination of the two components.

2. Explain that, for the third round of the Delphi we would like to separate the impacts of increased Extension and education from those of more complex OPM programs, where applicable.

   Inform the panel that you have, for their use, a list of specified "additional resources" by subregion.

3. Review, with panel members, the portions of tables 2 and 5, and/or Tables 13 and 14 that apply to your region's OPM estimates.

   *Ask panel members to consider whether their second round OPM estimates represent the combined impacts of increased Extension/education, and diapause control or if they are restricted to the impacts of increased Extension/education only.

4. Select a single subregion for more in-depth review:

   IF THE SUBREGION'S OPM ESTIMATES REPRESENT DELPHIED "MOPM" AND DIAPAUSE WOULD BE UNNECESSARY, proceed as for CIC review steps 3-7. <u>Label that subregion's program as "MOPM" as part of record-keeping.</u>

   IF THE SUBREGION'S OPM ESTIMATES INCLUDE THE IMPACTS OF EFFECTIVE DIAPAUSE AND/OR PIN HEAD SQUARE CONTROL, proceed to steps 5-8 below.

5. Compare Cooke's data with 2nd-round OPM estimates. Follow the equivalent of CIC review steps 4-7, with one additional consideration:

   *Compare <u>2nd</u>-round Delphi estimates of percent participation in a diapause control program with estimates provided by the BET of what minimum percent participation is required for effective diapause control. Are they within 5 percent of one another? If so, they can be considered in agreement. If not, the Delphi panel must explain their lower estimate. Only if they defend it by showing that isolated areas will participate at a rate that meets or exceeds the BET figure, will the assumption of effective OPM be upheld. Call in Cross, Young or other BET member to help resolve questions or issues regarding this item.

6. Reiterate to panel members the assumption that OPM is effective. Explain (or have a resource person explain) the difference between full incentives, phased incentives and no incentives.

   ASK:

   a) Can the effective program criteria (performance and participation) be met with full incentives?

   b) Can the effective program criteria be met in year 5 with a phased incentives scheme? If so, to what extent (over area of subregion)?

   c) Can the effective program criteria be met with no incentives? If so, to what extent (over area of subregion)?

      Answers are to be recorded by each panel member on the OPM participation question sheets provided. Give to computation expert for averaging and record keeping. Allow another round of feedback, response and revision on these percentage rates.

7. Consider the same subregion. Now, Delphi the impact that increased Extension/education only (without organized diapause control) would have on insecticide use and yield. Do this by:

   a) Going through the original Delphi process: each panel member fills out a NEW questionnaire for MOPM, OR

   b) Making relative changes from OPM or CIC responses already finalized: each panel member makes revisions on the computerized copy of his CIC or OPM responses. Label these well! Record and transmit to data input people.

   Use resource estimates provided by Starbird as input criteria for MOPM.

8. Repeat steps for OPM review for all other subregions in region.

C. BWE Review

BWE review and finalization should proceed along the same lines as OPM review.

Remember: we have a new BWE option to Delphi. To Delphi the impact of CIC-BWE on insecticide use and yield, do one of the following:

1. Go through the original Delphi process: each panel member fills out a NEW questionnaire for CIC-BWE, OR

2. Have panel members indicate the relative difference in variables between OPM-BWE and CIC-BWE, or between CIC and CIC-BWE. Record, label and transmit changes with care.

D. Follow-up - Have each panel member rate his familiarity with the various subregions. Use the form provided. Make results available to Kitty Reichelderfer.

THROUGHOUT THE PROCESS, PLEASE PAY SPECIAL ATTENTION TO CLEAR LABELING OF RESPONSES, TO CAREFUL RECORDING OF NEW ACTIONS, ASSUMPTIONS AND DATA, AND TO TRANSMISSION OF INFORMATION TO DATA INPUT PEOPLE AND THOSE PEOPLE RESPONSIBLE FOR FINAL DELPHI DATA SUMMARIZATION.

ATTACHMENT E

PARTICIPATION FOR EFFECTIVE BOLL WEEVIL
CONTROL UNDER OPM

Participation for Effective Boll Weevil Control Under OPM*

The question: "What average percentage of cotton acreage in the subregion in an average climate year would have to be included under OPM with fall diapause treatments to maintain the boll weevil as a sub-economic pest?" Remember that required participation by acreage could range from 0 to nearly 100 percent depending upon the geographic position in respect to boll weevil distribution. The boll weevil has the potential of reaching economic status in much of its range in the U.S. a majority of years and of reaching economic status in some fringe areas in only occasional years (Figure 1). The latter areas average too cold during overwinter hibernation (north-central) or too dry and/or devoid of suitable hibernation habitat (western). Short-season cotton varieties may be an additional factor. With these criteria in mind, the required participation expressed as percentage of acreage is presented in Figure 2 by subregions.

* Summarized by W. H. Cross and R. E. Frisbie.

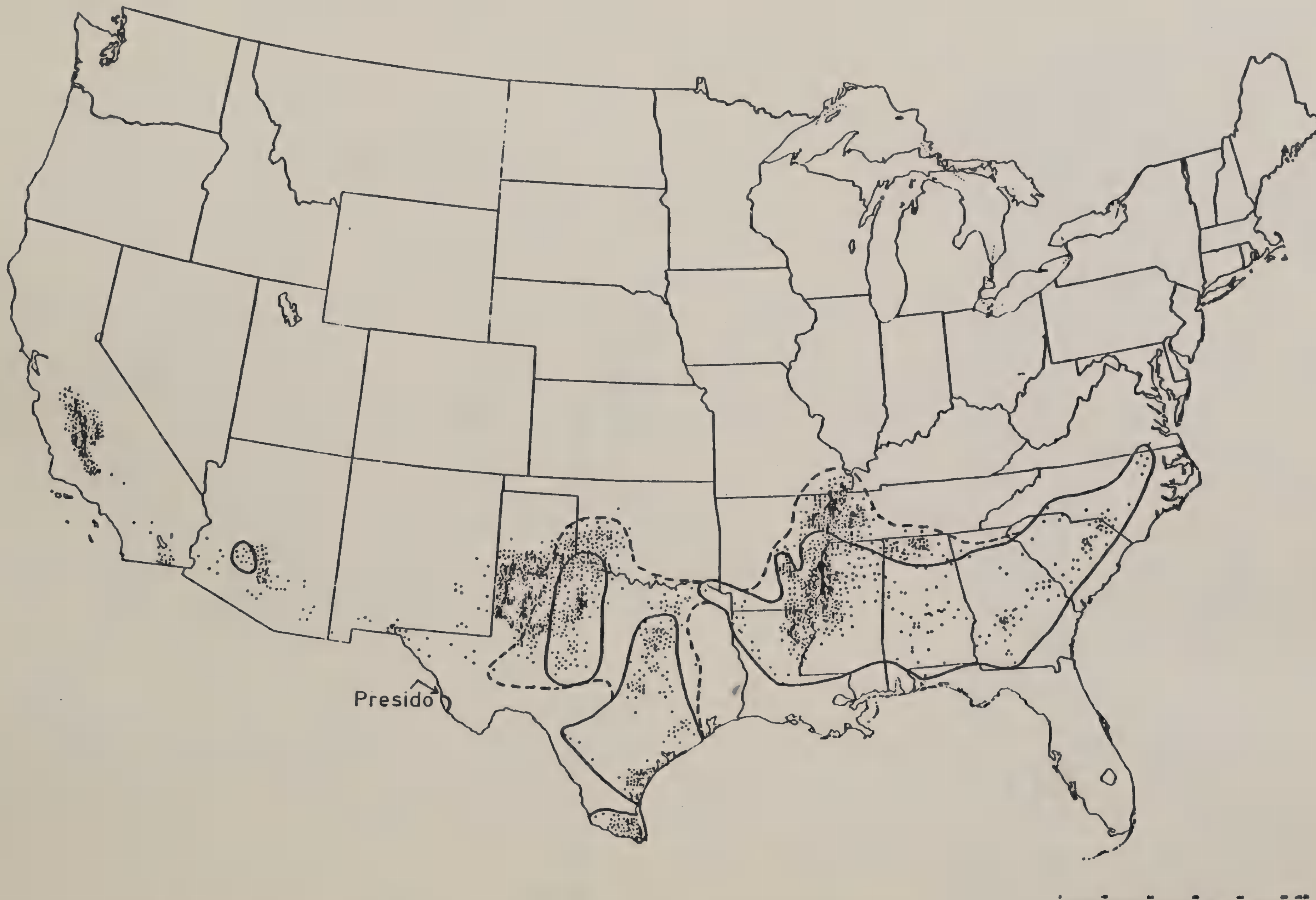

Fig. 1. United States cotton, average 1974-78, with one dot per 5000 acres, and boll weevil distribution in solid lines with potential for reaching economic status in majority of years (Arizona in stubbed cotton only) and in dashed lines with potential for reaching economic status in occasional years.

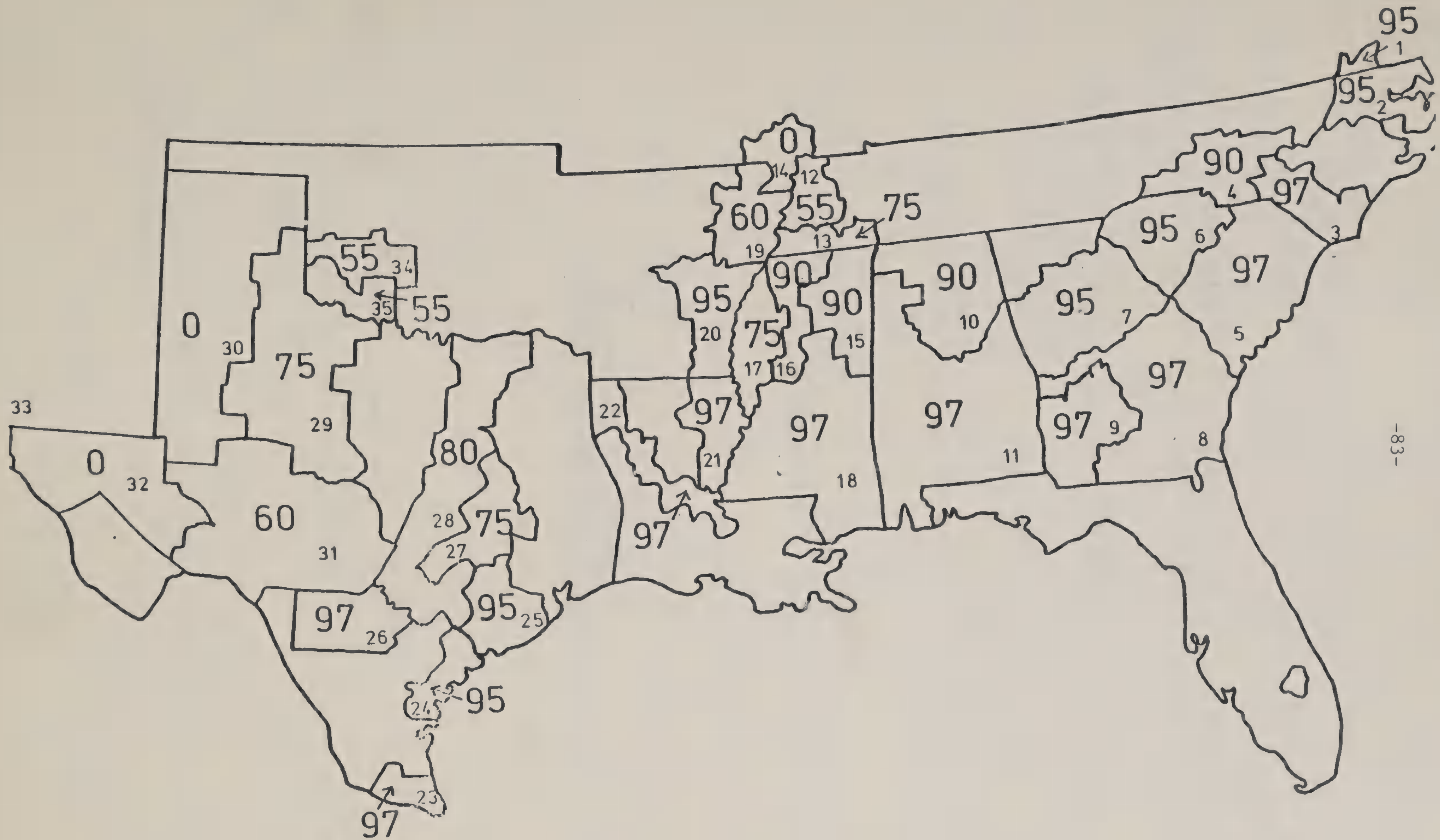

Fig. 2. Cotton production subregions 1-35 (small numbers) showing average percentage (large numbers) of acreage required under OPM with diapause treatments to maintain the boll weevil as a subeconomic pest.

ATTACHMENT F

STATEMENTS OF RATIONALE BY DELPHI PANEL MEMBERS, BY REGION

Delphi Cotton Expert Panel A Rationale for Observed Relationships among Third Round Delphi Estimates

I. General comments

Region A is the region where boll weevil is the greatest problem. The Delphi yield changes attributable to its eradication or improved management are reasonable. (5)*

In Regions B and C, boll weevil is "an insignificant pest" (except in some small areas). Thus, no significant yield change attributable to weevil control is valid for these regions. (5)

Interregional pattern described by Delphi panels is "very logical". (5)

Eradication should not significantly affect any region other than Region A (although some subregions in other regions would realize impacts). (5)

Feels "real good" about Delphi results. (5)

Is uncomfortable with the need for the Delphi panelists to have had to assume no change in acreage. Believes acreage shifts would occur and would result in more significant changes than were projected under that assumption. (4)

Is satisfied, in general, with the Delphi process and results. (3)

The large degree of variability among growers and environmental variables must be kept in mind and used during interpretation of the Delphi data. (6)

"The Delphi numbers are realistic" and they represent the average for an average year under the conditions described by program definitions. (6)

The estimates are "within significant statistical bounds". (6)

The only real problem with the boll weevil, beltwide, is that it starts us on an early spray schedule. (6)

In much of Regions B and C (especially Arkansas, Missouri and Mississippi, and particularly in Delta areas) they've eliminated weevil habitat and have no economic impact from weevils. Region A has more of a threat (from weevils). Trashy land and forested areas provide good overwintering habitat. Degree of land clearance is closely related to the impact of the weevil and its eradication. (2)

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* Number in parentheses refers to the individual panel member who provided the preceeding comment.

In general, is "pretty pleased with the Delphi in terms that it is the best means for our projecting impacts". It gives a generally accurate picture of what goes on. The Delphi information is the most accurate to come out of this project. (1)

The biggest problems with the boll weevil are that it increases the cost of cotton production and can make worm problems more significant. (1)

Weevil is such a minor pest over most of the rest (excluding Region A) of the cotton belt that Delphi yield change estimates from Regions B and C make sense. Elimination of an insignificant pest should not significantly affect yield. (1)

Fears possible tendency to extrapolate N.C. experience, which took place during very atypically light pressure years. (1)

II. Regarding the observation that costs and numbers of applications are highest under OPM in all subregions of Region A:

Under OPM, annual diapause treatments are required. Diapause treatments would not be completely offset by a reduction in in-season applications. (5,8,3,2,1)

In some subregions or areas, OPM represents addition of diapause treatment to a system that doesn't need it. (5)

Sees group saying, and agrees, that area wide diapause control would not provide great benefits in Region A. (8)

Diapause control cannot accurately account for low population years. It is a preventative rather than a prescriptive strategy. It will reduce in-season treatments, but not, under normal conditions, by enough to offset the number of preventative diapause treatments required. (2)

III. Regarding observation that MOPM & BWE costs and numbers of application are lowest for all subregions in Region A:

MOPM & BWE provides two benefits to the grower: elimination of the boll weevil, which in turn decreases worm problems, and; increased Extension resources which will improve management overall. (5)

IV. Other comments with respect to cost and application estimates:

A change from CIC to MOPM can result in either a net increase or net decrease in the number of applications made (and cost). The direction of change depends upon the current pattern (underutilization <u>vs</u> overutilization) of insecticide use, and will vary from subregion to subregion. (2)

V. Regarding observation that yields are lowest under CIC and highest under MOPM & BWE:

Yield increases under MOPM & BWE are due to the combined effects of: elimination of risk of weevils and; increases in the level of expertise which would include advice on and better management of other pests, agronomic practices, etc. (2, and others)

VI. Regarding MOPM and OPM yields as compared with CIC yields:

OPM and MOPM are important because the increase in Extension input will result in more attention being paid to individual growers. Farmers "try harder" under good attention. (4)

Better management will increase yields. (1,2,3,4,5,6,8)

Under MOPM, you have weevils in-season and direct some sprays at it. These early sprays also lend control to some incidental pests. By managing weevils at that time, you also pick up control of other complexes, specifically plant bugs. (3)

In going from CIC to MOPM, you get yield increases due to things other than weevil control. These include: better timing of plant bug and bollworm applications; better weed control; advice on a range of production problems. (2)

Going from CIC to OPM both eliminates in-season risk from boll weevils and increases proficient use of resources in all respects. (2)

VII. Regarding difference between yield estimates under MOPM and OPM:

There should be no significant difference between MOPM and OPM yields. (5,8,2,1)

Since management input is at the same level under OPM and MOPM and only the predominate method of weevil control varies between the options, yields should be equal. (1,8,)

NOTE: In no case did MOPM and OPM yield estimates differ by more than one pound lint per acre. The panel members unanimously agreed to use the average of OPM and MOPM yield estimates to represent a constant yield under both OPM and MOPM options.

VIII. Regarding the observation that CIC & BWE yield estimates are higher than those for CIC but lower than those for OPM and MOPM:

If you eliminate the weevil, that is not the only pest influencing yield. Without an increase in grower education, maximum yield increases will not be observed. (5)

BWE improves yields. But manpower will do more to increase yields than will boll weevil eradication. The weevil is not the key, or limiting insect pest, yield-wise. It is not as important as bollworms. Increases in manpower and education will reduce yield losses attributable to pests that have greater impact on yield. (8)

If you take weevils out of the system but do not increase grower education, producers cannot take best advantage of the situation. (3)

In going from CIC to CIC & BWE, you still incorporate misapplications of pesticides and some poor management practices. The option increases yield only due to elimination of weevil. Increased management will result in yield increases due to improvement in a range of areas. (2)

If weevil is "in the picture", cost is affected more than yield. Weevil prefers squares. The cotton plant can compensate, to some degree, under most circumstances, for square damage. The management options help increase yield due to improvement in many, often more important areas of plant protection. (1)

IX. Other comments regarding estimated yield differences:

Eradication will result in some yield benefit in Region A. It also has benefits in terms of worm control because it allows for conservation of natural enemies. Would expect worm populations under eradication to be less than or equal to those experienced with presence of boll weevils. (5)

All yield changes are attributable to changes in insect management. (5, and others)

NOTES from Delphi Panel B

1. In regions with heavy insect problem (Reg. 12 & 20) they may have overused insecticides and MOPM will reduce costs because less applications applied.

2. In regions (14 & 19) where they are currently not doing much for insect control, then MOPM would bring in additional acres and get a better job of insect control.

3. MOPM would bring in some acres for diapause control but OPM with full incentives would bring more acres and a few more applications into the program.

4. BWE-MOPM -- might make more applications under good management system and thus higher costs than BWE-CIC. Impact on yield won't be too great.

5. Region 19 -- boll weevil not giving any yield reduction. MOPM gives better management of other pest problem. OPM with incentives will pull in a few marginal farmers.

6. CIC maybe a little low - maybe $5. All other options should be raised $5.

7. Estimates influenced by most recent years.

8. In all regions yields for MOPM-BWE should be greater than CIC - BWE.

9. CIC vs MOPM -- Put more people in the field to gather and disseminate information. Farmer will apply more timely applications. Take away the wash day approach.

10. MOPM - OPM -- When you have incentives more people will participate in a diapause control program compared to MOPM. Level of awareness will increase compared to MOPM.

11. BWE-CIC and BWE-MOPM -- Boll weevil is gone to trigger insecticide use. Now looking at specific pests that are left. Farmers will have a better awareness of problems with MOPM and more farmers will control the remaining pests.

12. Region 14 -- Boll weevil is not a problem. Farmers are barely tuned into insect problems. MOPM will make them aware of minor insect problems. Point out that even though boll weevil is sporadic problem there is value to diapause control when it covers a wider area and MOPM should bring this about.

13. OPM - bring more acreage in and more applications and better area wide control.

14. With CIC, focus is on boll weevil and MOPM will have an impact on cost and yield.

15. After BWE there will be better management of remaining insects with MOPM.

16. In Regions 14 & 19 MOPM will focus on other insects because the boll weevil is not much of a problem.

17. Yield will be higher for MOPM-BWE compared to CIC-BWE.

18. Region 20 - CIC costs should be about $25 per acre. Adjust other costs by $5.

19. Region 20 & 12 — under MOPM will have less expenditures for unnecessary treatment of bollworm and other insects. Closer supervision and better management. OPM will bring more acres and diapause applications.

20. Region 14 & 19 -- Treat more under MOPM and OPM because of more supervision and dispause treatments. Take boll weevil out and look at plant bugs and other insects that you didn't know were a problem.

PANEL C

JUSTIFICATIONS OF BOLL WEEVIL COST AND YIELD ESTIMATES

I. Small Yield Effects

Just removal of the weevil alone will not affect yields much because weather and agronomic factors are the most limiting factors. Inputs are designed for a given yield, and farmers will control insects accordingly (1).

Most growers are operating at close to maximum yield. These programs will not change this much (2, 3, 4, 5). Consultants will dilute any program effects in the Delta (1). The weevil is not a major yield factor so removal of it will not result in much yield change (3). Removal of the weevil won't help much because most of the insect program is for Heliothis, and this will continue (6). There will not be a large yield effect in South Mississippi because much of the acreage of this area is in Yazoo and Warren counties and the weevil population is not too high there (7, 8).

When weevils are removed farmers get in the habit of not spraying and they may have some yield loss due to boll worms (1). One percent yield changes are impossible for us to estimate even if they are present (3).

II. Why Will Diapause Treatments be Low?

Extension efforts to get farmers to apply diapause treatments even if financially supported will not be as high as they think (9, 6). Weevils are light in the Delta region (1, 2, 3, 5). Many areas will not need to be treated at all, so the average for the regions are low (1, 3).

III. Why are the Program Effects on Insecticide Costs Low?

The weevil is not a major pest in several regions (3, 9). There will be additional treatments for other early season pests (1, 2, 5, 6, 7). Insecticide use may increase from eradication in some cases because of secondary insects (1).

Detailed Comments Volunteered by a Region C Panel Member

In reviewing the Delphi process, I felt that there was a need to try and clarify some points where we have differed with some of the other groups, especially as pertaining to yield responses.

In the Delphi process we have in essence considered a growing crop with current inputs and a multifaceted pest complex. Then we considered the effects on that crop with the removal of one of these pests. Even in the OPM strategies (OPM & MOPM) we have made the assumption that the boll weevil will no longer be a major economic problem. In my opinion, if we simply remove the pest, then effect upon the yields will in essence be nil, as good producers are presently using pesticides to control the pest which occur as they occur. In the second case, we should not underrate the plant with which we are dealing. The cotton plant has a tremendous ability to compensate for and replace large numbers of fruiting forms destroyed by insects or other inclimate factors. This fact is borne out by volumes of research and is one of the age old reasons for maintaining indeterminate gene pools of cotton in the mid-south.

It comes down, then, to an evaluation of the educational effects that additional personnel will have upon the producers. The tremendous effects are exemplified by the increased yields in the OPM trial. I would suggest that these same effects have occurred in the eradication trial. With the presence of large numbers of professionals and/or para-professionals comes change. Management practices for insects are definitely affected, but there will also be other changes made as a result of their presence and influence on yields. For example, until some of these programs (OPM, IPM and others) emerged many producers did not even know the county agent; now they not only know him but are actively calling upon him to help with most of their on the farm problems.

As for instituting the program without educational benefits or with reduced education, I feel that it would be a great mistake. It might be clarified with an example from past years in Pontotoc County, Mississippi. In the early to mid 1970's, insects (boll weevil and bollworms) occurred in low numbers in most of the county. As a result of this good fortune, producers were able to make average and above average crops with very few insecticidal inputs (2-3 applications). Then in the late 1970's both weevils and worms increased until there was a great need for (in some cases 8-12) applications to obtain adequate control of pests. Many producers resisted making these applications and as a result had severely reduced yields. Some still have not recovered as they (1) lost confidence in their pesticides (2) lost confidence in their advisors (county and area extension personnel). If we initiate a massive program with an influx of trained personnel, they get the job done, and then move on to other areas, there is a danger of leaving a vacuum which cannot be adequately filled by existing personnel. Thus, when a problem fills the void left by the pest removed, the reaction will be to do nothing. If nothing is done and crop losses result, extreme loss of confidence will occur and we will be worse off than when we began. With additional personnel in place permanently, confidence and technology can increase at fairly equal levels, enabling progress and efficiency in crop production.

The effects will not only be felt in cotton production, but in all crops. There is a potential for creating a network of communication and education to the grass roots producer as has never been realized. We can then begin to bring below average producers up to their potential in production. I am enthusiastically in favor of removing the weevil as a major economic pest because I believe that it will make the entomologists' and the producers' jobs easier, but only if we work to prevent that void from being filled with another equally destructive and dangerous pest. Yield increases will ultimately result through contact of producers with trained professionals who can help them to anticipate and better manage production problems as they arise.

Rationale for Delphi Estimates for Region D

Several questions have been raised about the estimates developed for Region D. They are: (1) a fairly large increase in yields from CIC to MOPM, (2) yield estimate differences among strategies were greater in this region than in other regions, (3) the relatively small differences in yield estimates for subregion 23 (lower Rio Grande irrigated) and subregion 40 (Rio Grande dryland) for higher levels of management, (4) the yields for current insect control practices for subregions 23 and 40, and (5) the large decreases in the number of insecticide applications per acre as producers move from CIC to MOPM in subregions 23, 26, and 27.

These issues were discussed by Delphi panel members. Following is a rationale developed by the panel members. In the lower Rio Grande, the experts feel that their estimates of yield for CIC practices are realistic. There have been some changes in technology that have brought about yield increases which are not reflected in historical yield data. Additionally, the experts feel that the small difference in yields between irrigated and dryland at higher levels of management is realistic. Irrigation can be counterproductive in that maturity can be delayed. It is possible with irrigation to obtain somewhat higher yields, but the cost of additional insecticide applications to obtain these yields may make this practice unacceptable from an economic viewpoint. It is viewed by the panel members that there is a move towards use of less irrigation because of the problem of delayed maturity, increased insect problems, late season storms damaging crops, and a number of other reasons.

The panel members feel the increases in yields that they have estimated are realistic. There are new technologies that are being adopted and the increased information on pest management practices provided through the Extension and private consultant input will substantially alter production practices. These alterations in practices will have significant effects on the average yields that will be realized in these regions. This will occur since a certain percentage of growers currently produce low yields as a result of no or inadequate insect control. With new technologies and expertise available, yields should increase. This is especially important because the weevil is a major problem in these areas. It is recognized in the southeast the weevil is also a major problem, but may not be as big a problem as bollworms and budworms. In Texas the weevil is the primary pest and the treatment of the weevil dictates other pest management and overall production practices.

The decrease in insecticide applications in regions 23, 26, and 27 also viewed to accurately reflect what will happen with the adoption of MOPM, OPM, or eradication. There are a number of areas in Texas where intensive insecticide practices are employed. This is documented by pesticide use surveys conducted by Texas. Since MOPM, OPM, and eradication provide for more education, more scouting, etc., the opportunity to greatly reduce the use of insecticides in these insecticide intensive areas is great. It is expected that the big change in yields in many areas will occur with MOPM and that with the adoption of more intensive management practices changes in yields will be less, but the number of applications will continue to decrease.

To some extent the estimates developed do not necessarily completely separate pest management practices from non-pest management cultural practices and it cannot be expected that experts should be able to do this. There are many interrelationships in management practices which have both direct and indirect effects on pest management. For example, the amount of nitrogen, extent and timing of irrigation, early harvest, and stalk destruction have effects on pest management requirements and practices. In assuming the adoption of MOPM and OPM, panel members in most cases implictely or explicitely assumed the adoption of all practices that were beneficial to the management of pests, i.e., integrated crop management involving all production practices.

ATTACHMENT G

REGIONAL INSECTICIDE MATERIALS AND
APPLICATION COSTS USED IN DELPHI ANALYSIS

Region A: Insecticide Materials Price List

Material	Price per lb. a.i.
Azodrin	$ 5.15
Bidrin	4.50
Cygon	6.50
Guthion	7.92
Methyl parathion	2.26
Pyrethroids	59.20
Lannate	11.20
Lorsban	6.50
Kelthane	5.00
Other	5.00

Region A

Materials	Rates of Application	Price per Application
EPN + M.P. (3 + 3)	* 0.5 + 0.5	$ 3.00
	0.6 + 0.6	3.50
	0.7 + 0.7	3.90
	0.75 + 0.75	4.28
	1.0 + 1.0	5.70
3 + 3 + ovicide	.5 + .5 + .12	$ 4.50
	* .5 + .5 + .125	4.60
	.5 + .5 + .25	6.20
	.6 + .6 + .125	5.10
	.75 + .75 + .125	5.88
	1.0 + 1.0 + .125	7.30
3 + 3 + lannate	* .5 + .5 + .125	$ 5.50
	.5 + .5 + .10	5.00
3 + 3 + lorsban	* .5 + .5 + .25	$ 4.62
	.5 + .5 + .5	6.25
Toxaphene + M.P.	0.5 + 0.25	0.65
	0.5 + 0.5	1.00
	0.5 + 1.0	1.75
	0.75 + 0.5	1.65
	1.5 + 0.5	2.00
	2.0 + 0.5	2.50
	* 2.0 + 1.0	3.28
	3.0 + 1.5	4.15
6 + 3 + ovicide	1 + .5 + .125	$ 3.10
	1 + 1 + .125	3.85
	1 + 1.5 + .125	4.60
	1.5 + 1.5 + .125	5.10
	2 + .5 + .125	4.10
	2 + .5 + .25	5.70
	* 2 + 1 + .125	4.88
	2 + 1 + .25	6.48
	2.5 + 1.25 + .125	4.95
6 + 3 + lannate	2 + .5 + .125	$ 4.00
	* 2 + 1.0 + .125	4.75
	2 + 1.0 + .10	4.45
6 + 3 + lorsban	.5 + .5 + .25	$ 2.47
	.5 + .5 + .5	4.10

Region A

Materials	Rates of Application	Price per Application
6 + 3 + azodrin	2 + 1 + 1	$ 8.40
6 + 3 + ovicide + guthion	2 + 1 + .12 + .25	$ 6.86
Pyrethroid + guthion	.10 + .25	$ 7.60
	.11 + .25	8.18
	.10 + .50	9.40
Pyrethroid + M. P.	.10 + .25	$ 6.57
	.10 + .50	7.05
	.10 + 1.0	8.18
	.12 + .40	7.86
	.12 + .50	8.10
	.125 + .25	7.65
Pyrethroid + ovicide	.10 + .125	7.42

Regions B and C: Insecticide Materials Price List

Material	Price per lb. a.i.
Azodrin	$ 5.05
Bolstar	7.10
Bidrin	4.50
Cygon (Dimethoate; Defend)	4.97
Galecron (ovicide)	12.00
Guthion	7.00
Lannate	11.20
Lorsban	6.50
Methyl parathion	2.15
Pyrethroids	58.00
Orthene (Acephate)	7.40
Sevén (Carbaryl)	2.12
Temik	12.33
B.t. (Dipel)	7.50
Toxaphene	0.92
Other	5.00

Regions B and C

Materials	Rates of Application	Price per Application
EPN + M.P	.25 + .25	$ 1.50
	* .50 + .50	2.55
	.60 + .60	3.00
	.70 + .70	3.50
	.75 + .75	3.75
	1.00 + 1.00	5.00
	1.125 + 1.125	5.50
	1.5 + 1.5	7.00
	1.0 + 2.0	6.50
	.50 + 1.0	4.00
EPN + M.P. + ovicide	.5 + .5 + .12	$ 3.75
	* .5 + .5 + .125	3.80
	.5 + .5 + .25	5.30
	.6 + .6 + .125	4.00
	.75 + .75 + .125	4.20
	1.0 + 1.0 + .125	4.50
EPN + M.P. + lannate	.5 + .5 + .125	$ 4.02
	.5 + .5 + .10	3.45
EPN + M.P. + lorsban	.5 + .5 + .25	$ 4.81
	.5 + .5 + .5	6.75
Toxaphene + M. P.	.50 + .25	$ 1.00
	.50 + .50	1.35
	.75 + .50	1.50
	1.50 + .75	2.10
	2.0 + .50	2.65
	* 2.0 + 1.0	3.30
	2.5 + 1.25	4.10
Tox. + M.P. + ovicide	1.0 + .5 + .125	$ 2.65
	2.0 + .5 + .125	3.50
	2.0 + .5 + .25	5.00
	* 2.0 + 1.0 + .125	4.80
	2.0 + 1.0 + .25	6.25
Tox. + M.P. + lannate	2.0 + .5 + .125	4.50
	* 2.0 + 1.0 + .125	4.80
	2.0 + 1.0 + .10	4.50
Tox. + M.P. + lorsban	.5 + .5 + .25	3.00
	.5 + .5 + .5	4.75
Tox. + M.P. + azodrin	2.0 + 1.0 + 1.0	$ 8.50

* most frequent rate

Regions B and C

Materials	Rates of Application	Price per Application
Tox. + M.P. + ovicide + guthion	2 + 1 + .12 + .25	$ 6.50
Pyrethroid + guthion	.10 + .25	$ 7.06
	.11 + .25	7.06
	.10 + .50	8.62
Pyrethroid + M.P.	.10 + .25	$ 6.06
	.10 + .50	6.60
	.10 + 1.0	7.68
	.12 + .40	7.46
	.12 + .50	7.68
	.125 + .25	7.74
Pyrethroid + ovicide	.10 + .125	$ 7.30
Dipel + ovicide	.25 + .125	$ 3.35
	.25 + .25	4.85
	.50 + .125	5.20
Dipel + M.P.	.25 + .25	$ 2.40
Dipel + ovicide + M.P.	.25 + .125 + .25	$ 3.90
M.P. + galecron	1.0 + .125	$ 3.65
M. P. + guthion	.25 + .25	$ 2.30
M. P. + Bolstar	.25 + .10	$ 1.25
M.P. + lannate	.45 + .125	$ 4.65
M.P. + lorsban + ovicide	1.0 + .5 + .125	$ 6.80
Lannate + lorsban	.33 + .50	$ 6.50
	.125 + 1.0	8.00
Lannate + ovicide	.45 + .125	$ 6.00

Regions D and E: Insecticide Materials Price List

Material	Price per lb. a.i.
Bolstar	$ 12.63 1/
Bidrin	5.01
Cygon (Dimethoate; Defend)	5.94
Galecron (ovicide)	15.00
Guthion	7.38
Lannate	12.00
Malathion	2.30
Methyl parathion	2.28
Pyrethroids	58.00
Sevin (Carbaryl)	2.25
B.t. (Dipel)	8.80
Elcar	8.00
Toxaphene	1.13
Other	5.00

1/ Information provided by James Conner suggests this may be a large overestimate of the price of Bolstar faced by producers in Regions D and E. Delphi results, however, were not found to be sensitive to Bolstar's price. Delphi responses did not indicate heavy use of Bolstar on cotton in these regions.

Regions D and E

Materials	Rates of Application	Price per Application
Pyrethroid + guthion	.10 + .25	$ 7.65
	.11 + .25	7.70
	.10 + .50	9.40
Pyrethroid + M.P.	.10 + .25	$ 6.40
	.10 + .50	6.95
	.10 + 1.0	8.05
	.12 + .40	7.90
	.12 + .50	8.15
	.125 + .25	7.65
Pyrethroid + ovicide	.10 + .125	$ 7.65
Dipel + ovicide	.25 + .125	$ 4.05
	.25 + .25	5.90
	.50 + .125	6.25
Dipel + M.P.	.25 + .25	$ 2.75
Dipel + ovicide + M.P.	.25 + .125 + .25	$ 4.60
Dipel + elcar	.50 + .50	$ 8.50
Dipel + galecron	.50 + .125	$ 6.25
M.P. + galecron	1.0 + .125	$ 4.15
M.P. + guthion	.25 + .25	$ 2.40
M.P. + bolstar	.25 + .10	$ 1.85
	.25 + .75	5.95
M.P. + lannate	.45 + .125	$ 2.65
Lannate + ovicide	.45 + .125	$ 7.25

Regions D and E

Materials	Rates of Application	Price per Application
EPN + M.P.	0.25 + 0.25	$ 1.20
(3 + 3)	0.50 + 0.50	2.35
	0.60 + 0.60	2.80
	0.70 + 0.70	3.25
	0.75 + 0.75	3.50
	1.0 + 1.0	4.65
	1.125 + 1.125	5.25
	1.5 + 1.5	7.00
3 + 3 + ovicide	.5 + .5 + .12	$ 4.15
	* .5 + .5 + .125	4.22
	.5 + .5 + .25	6.00
	.6 + .6 + .125	4.65
	.75 + .75 + .125	5.35
	1.0 + 1.0 + .125	6.50
3 + 3 + lannate	* .5 + .5 + .125	$ 3.85
	.5 + .5 + .10	3.55
Toxaphene + M.P.	.50 + .25	$ 1.00
	.50 + .50	1.35
	.50 + 1.0	2.50
	.75 + .50	1.70
	1.5 + .50	2.15
	1.5 + .75	2.50
	2.0 + .50	2.60
	* 2.0 + 1.0	3.70
	2.5 + 1.25	4.70
	3.0 + 1.5	5.70
Tox. + M.P. + ovicide	.5 + 1.5 + .125	$ 5.25
	1.0 + .5 + .125	4.15
	1.0 + 1.0 + .125	5.15
	1.0 + 1.5 + .125	5.60
	1.5 + 1.5 + .125	6.60
	2.0 + .5 + .25	6.35
	* 2.0 + 1.0 + .125	5.60
	2.0 + 1.0 .25	7.45
	2.5 + 1.25 + .125	6.55
Tox. + M.P. + lannate	2 + .5 + .125	$ 4.25
	2 + 1.0 + .125	5.20
	2 + 1.0 + .10	4.90
Tox. + M.P. + ovicide + guthion	2 + .5 + .125	$ 7.25

Subregional Average Application Costs

Subregion	Assumed average application cost per acre
2	$ 1.50
3	1.25
5	1.52
6	1.71
7	1.71
8	1.80
9	1.80
10	1.41
11	1.50
12	1.75
13	1.75
14	2.00
15	1.40
16	1.35
17	1.25
18	1.38
19	1.28
20	1.28
21	1.90
22	1.90
23	2.00
24	2.25
25	2.15
26	2.00
27	2.15
29	1.75
30	2.25
31	2.00
40	2.00

ATTACHMENT H

BIOLOGICAL EVALUATION TEAM AND DELPHI PANEL MEMBER ESTIMATION OF AVERAGE RATES OF PARTICIPATION IN OPM DIAPAUSE AND/OR OVERWINTER CONTROL PROGRAMS

ATTACHMENT H: Biological Evaluation Team and Delphi panel member estimation of average rates of participation in OPM diapause and/or overwinter control programs (Rate shown applies uniformly over total subregional acreage unless otherwise specified)

Region and Subregion	BET estimated avg. percentage of acreage required for effective OPM	Average participation rate estimated by Delphi panel members 1/ PHASED INCENTIVES OPM	NO INCENTIVES OPM
Region A			
1 & 2 - North Carolina, North plus Virginia	95	[95% on 80% of area] 2/	[95% on 50% of area]
3 - North Carolina, South	97	under 80% in all areas	under 80% in all areas
5 - South Carolina, Coastal	97	under 80% in all areas	under 80% in all areas
4,6 & 7 - South Carolina, Piedmont Georgia, Piedmont, and North Carolina, Piedmont	90-95	under 80% in all areas	under 80% in all areas
8 - Georgia, East	97	57%	20%
9 - Georgia, Southwest	97	50%	22%
10 - Alabama, North	90	10%	8%
11 - Alabama, South	97	5%	1%
Region B			
12 & 13 - Tennessee	55 and 75	[75% on 51% of area]	[67% on 51% of area]
14 - Missouri	0	[73% on 30% of area]	[65% on 30% of area]
19 - Arkansas, Northeast	60	[83% on 23% of area]	[80% on 23% of area]
20 - Arkansas, Southeast	95% on 20% of area	84% on 42% of area	81% on 42% of area

Region and Subregion	BET estimated avg. percentage of acreage required for effective OPM	Average participation rate estimated by Delphi panel members	
		PHASED INCENTIVES OPM	NO INCENTIVES OPM
egion C			
5 - Mississippi, Northeast	90	82%	72%
6 - Mississippi, North Central	90	79%	71%
7 - Mississippi, Delta	90% on 20% of area	73%	66%
8 - Mississippi, South	97	82%	70%
!1 - Louisiana, Northeast	97	82%	71%
!2 - Louisiana, Red River Valley	97	81%	71%
tegion D			
!3 - Lower Rio Grande	97	77.5% on 76% of area	66% on 76% of area
40 - Lower Rio Grande Dryland	97	63% on 63% of area	48% on 63% of area
24 - Texas, Lower Bend	95	80% on 57% of area	73% on 57% of area
25 - Texas, Upper Bend	95	80% on 86% of area	75% on 86% of area
26 - Winter Garden	97	79%	73%
27 - Central River Bottom	90	70%	64%
28 - Texas Blacklands	80	73% on 65% of area	63% on 65% of area
Region E			
29 - Texas, Rolling Plains	75	40%	15%
30 - Texas, High Plains	0	N/A	N/A

Region and Subregion	BET estimated avg. percentage of acreage required for effective OPM	Average participation rate estimated by Delphi panel members	
		PHASED INCENTIVES OPM	NO INCENTIVES OPM
31 - Upper Concho Basin	60	40%	15%
32 & 33 - Pecos and El Paso Valleys	0	N/A	N/A
34 & 35 - Oklahoma	55	40%	25%

1/ Participation rates shown are the statistical means of panel member estimates of participation rates. Panel members' median and modal responses also were determined. Only in the case of subregion 26 does the use of modes or medians change the OPM-NI or OPM-PI option participation rate from being insufficient for effective OPM to meeting the required participation rate estimated by the BET (Attachment E).

2/ Bracketed expressions indicate phased and no incentives option participation rates sufficient for effective OPM in at least a portion of subregional area. Feasibility is determined by comparing panel members' participation rate estimate with that estimated by the BET as the required participation rate.

ATTACHMENT I

DELPHI CRITIQUE FORM

AND

SUMMARY OF RESPONSES TO DELPHI CRITIQUE

DELPHI CRITIQUE FORM 1/

A. Your role in the Delphi process:

/__/ Panel member   /__/ Facilitator

/__/ Resource person   /__/ Administrator

B. Delphi panel with which you participated (if applicable):

/__/ Region A   /__/ Region D

/__/ Region B   /__/ Region E

/__/ Region C

C. PANEL MEMBERS ONLY:

Please indicate the extent of your agreement or disagreement with each of the following statements regarding the Delphi by checking the appropriate box. ALL OTHER PARTICIPANTS SKIP TO ITEM D, on page 7.

1. The resource presentations made at the Memphis meetings were helpful to me in terms of responding to the Delphi questionnaire.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	-	2	-	-	-	-	2 (7%)
/__/ Agree	1	3	2	2	1	-	9 (32%)
/__/ Agree somewhat	2	-	3	3	1	1	10 (36%)
/__/ No opinion	-	-	-	-	-	-	0
/__/ Disagree somewhat	1	-	1	-	-	-	2 (7%)
/__/ Disagree	2	-	1	1	-	-	4 (14%)
/__/ Strongly disagree	1	-	-	-	-	-	1 (4%)
							28

Average response: 2/

SA	A	AS	DS	D	SD
I	I	I	I	I	I
		* *			

1/ Includes summary of responses. The number of responses in each response category and the percentage of total responses falling in each category are shown for each of statements 1-22.

2/ The average of all responses is indicated by a set of asterisks (*) placed along a scale of response categories. Abbreviations are as follows: SA = strongly agree; A = agree; AS = agree somewhat; DS = disagree somewhat; D = disagree; and SD = strongly disagree.

2. I was provided, or could obtain on my own, the background information necessary to respond to the Delphi questionnaire.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	1	1	-	1	-	-	3 (11%)
/__/ Agree	4	2	4	2	2	1	15 (54%)
/__/ Agree somewhat	-	2	-	1	-	-	3 (11%)
/__/ No opinion	1	-	1	-	-	-	2 (7%)
/__/ Disagree somewhat	1	-	1	1	-	-	3 (11%)
/__/ Disagree	-	-	1	1	-	-	2 (7%)
/__/ Strongly disagree	-	-	-	-	-	-	0
							28

Average response:

```
SA     A      AS     DS     D      SD
I      I      I      I      I      I
_________________________________________
          *
          *
```

3. The questions on the Delphi questionnaire were precise and unambiguous.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	-	-	-	-	-	-	0
/__/ Agree	-	-	1	1	1	-	3 (11%)
/__/ Agree somewhat	3	5	2	1	-	1	12 (43%)
/__/ No opinion	-	-	-	-	-	-	0
/__/ Disagree somewhat	1	-	2	1	1	-	5 (18%)
/__/ Disagree	3	-	1	1	-	-	5 (18%)
/__/ Strongly disagree	-	-	1	2	-	-	3 (11%)
							28

Average response:

```
SA     A      AS     DS     D      SD
I      I      I      I      I      I
_________________________________________
                     *
                     *
```

4. It was difficult to use the Delphi questionnaire to describe the average insecticide use patterns I believed would result under alternative boll weevil/cotton insect management options.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	D	Unidenti-fied	Total
/__/ Strongly agree	2	-	3	2	-	-	7 (25%)
/__/ Agree	2	1	2	3	1	1	10 (36%)
/__/ Agree somewhat	1	1	1	-	1	-	4 (14%)
/__/ No opinion	-	-	-	-	-	-	0
/__/ Disagree somewhat	2	2	-	-	-	-	4 (14%)
/__/ Disagree	-	1	1	-	-	-	2 (7%)
/__/ Strongly disagree	-	-	-	1	-	-	1 (4%)
							28

Average response:

SA A AS DS D SD

I I I I I I

*
*

5. The Delphi interim summary statistics fed back to panel members between the first and second, and second and third rounds of the Delphi process were easy to interpret.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidenti-fied	Total
/__/ Strongly agree	1	1	-	1	-	-	3 (11%)
/__/ Agree	4	1	3	2	1	-	11 (39%)
/__/ Agree somewhat	1	1	3	-	1	-	6 (21%)
/__/ No opinion	-	-	-	-	-	-	0
/__/ Disagree somewhat	1	2	1	3	-	1	8 (29%)
/__/ Disagree	-	-	-	-	-	-	0
/__/ Strongly disagree	-	-	-	-	-	-	0
							28

Average response:

SA A AS DS D SD

I I I I I I

*
*

6. The Delphi interim summary statistics were overwhelming; too much material was provided.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	-	-	-	1	-	-	1 (4%)
/__/ Agree	1	1	-	1	1	-	4 (14%)
/__/ Agree somewhat	3	1	2	1	-	-	7 (25%)
/__/ No opinion	-	-	1	-	1	-	2 (7%)
/__/ Disagree somewhat	-	2	2	-	-	1	5 (18%)
/__/ Disagree	3	1	2	2	-	-	8 (29%)
/__/ Strongly disagree	-	-	-	1	-	-	1 (4%)
							28

Average response:

```
SA        A         AS        DS        D         SD
I         I         I         I         I         I
__________________________________________________________
                             *
                             *
```

7. The facilitator for my group prevented domination of the group activities by any one or a few individuals.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	3	1	1	4	1	-	10 (36%)
/__/ Agree	3	4	5	2	1	-	15 (54%)
/__/ Agree somewhat	-	-	-	-	-	-	0
/__/ No opinion	1	-	-	-	-	-	1 (4%)
/__/ Disagree somewhat	-	-	1	-	-	1	2 (7%)
/__/ Disagree	-	-	-	-	-	-	0
/__/ Strongly disagree	-	-	-	-	-	-	0
							28

Average response:

```
SA        A         AS        DS        D         SD
I         I         I         I         I         I
__________________________________________________________
             *
             *
```

8. The facilitator did not attempt to influence the outcome of the exercise by suggesting responses.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	2	4	1	2	-	-	9 (32%)
/__/ Agree	4	1	6	3	2	-	16 (57%)
/__/ Agree somewhat	1	-	-	-	-	1	2 (7%)
/__/ No opinion	-	-	-	-	-	-	0
/__/ Disagree somewhat	-	-	-	-	-	-	0
/__/ Disagree	-	-	-	1	-	-	1 (4%)
/__/ Strongly disagree	-	-	-	-	-	-	0
							28

Average response:

```
SA        A        AS        DS        D        SD
I         I        I         I         I        I
_______________________________________________________
          *
          *
```

9. The Delphi process allowed me the freedom to disagree with other panel members.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/__/ Strongly agree	2	4	3	5	1	-	15 (54%)
/__/ Agree	3	1	2	1	1	1	9 (32%)
/__/ Agree somewhat	1	-	1	-	-	-	2 (7%)
/__/ No opinion	1	-	-	-	-	-	1 (4%)
/__/ Disagree somewhat	-	-	1	-	-	-	1 (4%)
/__/ Disagree	-	-	-	-	-	-	0
/__/ Strongly disagree	-	-	-	-	-	-	0
							28

Average response:

```
SA        A        AS        DS        D        SD
I         I        I         I         I        I
_______________________________________________________
       *
       *
```

10. The Delphi process provided the opportunity for anonimity of my responses to the questionnaire.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/_7 Strongly agree	1	1	-	2	-	-	4 (14%)
/_7 Agree	2	4	1	1	1	-	9 (32%)
/_7 Agree somewhat	1	-	1	-	1	1	4 (14%)
/_7 No opinion	2	-	1	-	-	-	3 (11%)
/_7 Disagree somewhat	-	-	2	1	-	-	3 (11%)
/_7 Disagree	-	-	1	2	-	-	3 (11%)
/_7 Strongly disagree	1	-	1	-	-	-	2 (7%)
							28

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
		*			
		*			

11. If given the opportunity, I would be willing to serve as an expert panel member in another similar Delphi exercise.

	Number (%) of responses by panel members						
	Region						
	A	B	C	D	E	Unidentified	Total
/_7 Strongly agree	2	2	-	2	-	-	6 (21%)
/_7 Agree	3	2	5	2	2	1	15 (54%)
/_7 Agree somewhat	-	1	-	1	-	-	2 (7%)
/_7 No opinion	-	-	2	1	-	-	3 (11%)
/_7 Disagree somewhat	1	-	-	-	-	-	1 (4%)
/_7 Disagree	-	-	-	-	-	-	0
/_7 Strongly disagree	1	-	-	-	-	-	1 (4%)
							28

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
	*				
	*				

D. <u>ALL DELPHI PARTICIPANTS, INCLUDING PANEL MEMBERS</u>: Please indicate the extent of your agreement or disagreement with each of the following statements regarding the Delphi by checking the appropriate box.

12. The Delphi regional panels were made up of individuals with a high degree of expertise in cotton insect management.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/_/ Strongly agree	9	2	3	14 (29%)
/_/ Agree	12	5	3	20 (41%)
/_/ Agree somewhat	1	5	-	6 (12%)
/_/ No opinion	-	-	-	0
/_/ Disagree somewhat	4	2	1	7 (14%)
/_/ Disagree	-	-	-	0
/_/ Strongly disagree	2	-	-	2 (4%)
				49

Average response:

SA I ——— A I ——— AS I ——— DS I ——— D I ——— SD I

*

*

13. The Delphi panels included individuals with a range of perspectives and experiences.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/_/ Strongly agree	14	3	2	19 (39%)
/_/ Agree	8	8	4	20 (41%)
/_/ Agree somewhat	4	3	-	7 (14%)
/_/ No opinion	-	-	-	0
/_/ Disagree somewhat	2	-	1	3 (6%)
/_/ Disagree	-	-	-	0
/_/ Strongly disagree	-	-	-	0
				49

Average response:

SA I ——— A I ——— AS I ——— DS I ——— D I ——— SD I

*

14. The Delphi panels were not biased with respect to overrepresentation by any one subgroup of individuals.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	7	1	-	8 (16%)
/__/ Agree	6	5	3	14 (29%)
/__/ Agree somewhat	6	2	2	10 (20%)
/__/ No opinion	1	2	-	3 (6%)
/__/ Disagree somewhat	4	2	-	6 (12%)
/__/ Disagree	-	-	2	2 (4%)
/__/ Strongly disagree	4	2	-	6 (12%)
				49

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
		*			
		*			

15. The Delphi process was well organized and proceeded in an efficient manner.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	3	-	-	3 (6%)
/__/ Agree	9	6	5	20 (40%)
/__/ Agree somewhat	10	3	1	14 (28%)
/__/ No opinion	1	-	-	1 (2%)
/__/ Disagree somewhat	3	3	-	6 (12%)
/__/ Disagree	-	2	1	3 (6%)
/__/ Strongly disagree	2	-	1	3 (6%)
				50

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I
		*			
		*			

16. The Delphi estimates are realistic representations of the average situations expected for an average year under the conditions described by program definitions.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	4	-	1	5 (10%)
/__/ Agree	12	3	4	19 (39%)
/__/ Agree somewhat	8	7	1	16 (33%)
/__/ No opinion	-	1	-	1 (2%)
/__/ Disagree somewhat	2	2	-	4 (8%)
/__/ Disagree	2	1	1	4 (8%)
/__/ Strongly disagree	-	-	-	0
				49

Average response:

```
SA        A         AS        DS        D         SD
I_________I_________I_________I_________I_________I
               *
               *
```

17. I believe the face-to-face interaction provided for among participants led to better estimates than could have been collected through a mail survey or other individual based survey methods.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	14	5	6	25 (50%)
/__/ Agree	10	7	1	18 (36%)
/__/ Agree somewhat	2	1	-	3 (6%)
/__/ No opinion	-	-	-	0
/__/ Disagree somewhat	-	-	-	0
/__/ Disagree	1	1	-	2 (4%)
/__/ Strongly disagree	1	-	1	2 (4%)
				50

Average response:

```
SA        A         AS        DS        D         SD
I_________I_________I_________I_________I_________I
       *
       *
```

18. The Delphi interim summary statistics were comprehensive; provided all information I needed to understand the group estimates.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	4	-	3	7 (14%)
/__/ Agree	15	4	3	22 (45%)
/__/ Agree somewhat	3	5	1	9 (18%)
/__/ No opinion	-	3	-	3 (6%)
/__/ Disagree somewhat	3	1	-	4 (8%)
/__/ Disagree	3	1	-	4 (8%)
/__/ Strongly disagree	-	-	-	0
				49

Average response:

```
SA          A           AS          DS          D           SD
I           I           I           I           I           I
------------------------------------------------------------------
                  *
                  *
```

19. The Delphi review and revision process was prematurely ended. More study and review time was needed.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	1	1	-	2 (4%)
/__/ Agree	5	2	-	7 (14%)
/__/ Agree somewhat	1	1	-	2 (4%)
/__/ No opinion	3	3	2	8 (16%)
/__/ Disagree somewhat	5	2	1	8 (16%)
/__/ Disagree	11	5	4	20 (40%)
/__/ Strongly disagree	2	-	-	2 (4%)
				49

Average response:

```
SA          A           AS          DS          D           SD
I           I           I           I           I           I
------------------------------------------------------------------
                                    *
                                    *
```

20. A byproduct of the Delphi meetings has been increased understanding and communication among cotton experts from various States and in various scientific disciplines.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/_/ Strongly agree	7	-	3	10 (20%)
/_/ Agree	11	7	4	22 (45%)
/_/ Agree somewhat	5	6	-	11 (22%)
/_/ No opinion	2	1	-	3 (6%)
/_/ Disagree somewhat	-	-	-	0
/_/ Disagree	2	-	-	2 (4%)
/_/ Strongly disagree	1	-	-	1 (2%)
				49

Average response:

```
SA     A     AS     DS     D     SD
I      I     I      I      I     I
_________________________________
        *
        *
```

21. Participation in the Delphi process was a waste of my time.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/_/ Strongly agree	1	-	-	1 (2%)
/_/ Agree	-	-	-	0
/_/ Agree somewhat	-	1	-	1 (2%)
/_/ No opinion	1	-	-	1 (2%)
/_/ Disagree somewhat	5	1	1	7 (14%)
/_/ Disagree	11	10	1	22 (44%)
/_/ Strongly disagree	10	2	6	18 (36%)
				50

Average response:

```
SA     A     AS     DS     D     SD
I      I     I      I      I     I
_________________________________
                            *
                            *
```

22. The Delphi results provided the best possible beltwide estimates of average subregional farm level impacts of a change in boll weevil/cotton insect management programs given: current state of knowledge and time constraints.

	Number (%) of responses by participants			
	Panel members	Resource people	Facilitators and administrators	Total
/__/ Strongly agree	8	1	3	12 (24%)
/__/ Agree	8	4	3	15 (31%)
/__/ Agree somewhat	5	6	-	11 (22%)
/__/ No opinion	1	2	-	3 (6%)
/__/ Disagree somewhat	5	-	-	5 (10%)
/__/ Disagree	-	1	1	2 (4%)
/__/ Strongly disagree	1	-	-	1 (2%)
				49

Average response:

SA	A	AS	DS	D	SD
I	I	I	I	I	I

*
*

E. Please estimate the number of man-hours you devoted to participation in the Boll Weevil/Cotton Insect Management Evaluation Delphi process. Include in your estimate time spent attending the meetings, reviewing interim summary statistics and, if applicable, revising estimates, providing rationales, preparing resource presentations and materials.

8,924 man-hours = sum of respondants' estimates

F. In the space provided below, please make any specific or overall comments that may help us evaluate the effectiveness of the Delphi process and the validity of the Delphi results.

(All comments have been compiled and sent to each Delphi participant.)

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